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THE ECOLOGY, ECONOMICS, AND MANAGEMENT OF MINK IN THE YUKON-KUSKOKWIM DELTA ALASKA

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By

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College, Alaska

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THE ECOLOGY, ECONOMICS, AND MANAGEMENT

OF MINK IN THE YUKON-KUSKOKWIM DELTA

ALASKA

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ABSTRACT

Studies of mink in the Yukon-Kuskokwim Delta of southwest Alaska were conducted from June, 1960, to February, 1962. These studies indicate that the most important food items of mink in this area are small mammals taken during the summer and blackfish taken during the fall and early winter. It was found that mink of this region mate during the second and third weeks of April, and have their young during the middle of June. Mink are very selective in their choice of natal den sites. Natal dens were always found in areas of deep annual thaw, under a plant cover of _Spiraea beauverdiana_ or _Salix_ spp. Suitable conditions occur most commonly on the banks of small streams, or on pingos.

Sex ratios of the 1960-1961 and 1961-1962 harvest were determined through examination of pelts. The sex composition was 59.3 per cent males during the 1960-1961 trapping season, and 67.2 per cent males during the 1961-1962 season. The difference was significant (Chi-square= 39.22), and was attributed to differences in trapping conditions and population levels. Certain skull measurements can be used to separate the sexes. These are the basilar length (of Hensel), and length of the tooth rows.

Age determinations were based on criteria established by previous investigators. The phenomenon of decreasing depth of skull with increasing age of mink, was brought to light. Differences in this measurement appear to correspond to different age groups.

Trapping methods, procedures and effects are considered, and it is concluded that the _taluyak_ is the most satisfactory trap for taking

mink in the Delta. The harvests of mink in the Delta ranged from 7,000 to 40,000 pelts per season, with a corresponding range in value of $175,000.00 to $1,000,000.00.

The most important factor responsible for population levels during any trapping season is the survival success of young mink born during the summer preceding the trapping season. Evidence indicates that the major factors affecting survival success are climatic. Seasons of high mink abundance followed breeding seasons during which warm, dry weather prevailed, and vice versa.

Several other aspects of the biology of mink are discussed including the effects of topographic features and heavy machinery on mink habitat. Heavy machinery, especially tracked vehicles, permanently destroys habitat by disrupting tundra vegetation. Disruption of the insulating mat of vegetation causes diffential thawing of permafrost, resulting in the formation of extensive thaw sinks.

It is thought that the value of mink taken in the Delta can be increased by uniform processing and quantity marketing of pelts.

PREFACE

This investigation was made possible by funds provided by Federal Aid in Wildlife Restoration, Project W-6-R-2, Work Plan G, Job No. 4, through the Cooperative Wildlife Research Unit of the University of Alaska. Investigation began in June, 1960, and was concluded in February, 1962.

Completion of this project is the result of effort by a great many people; they are too numerous to mention each by name. A few of the people instrumental in the completion of this study, and to whom I am especially thankful, include: Dr. Frederick C. Dean for his efforts in directing this study, and for his invaluable help in reviewing this thesis; Mr. Robert F. Scott, Unit Leader, who initiated the project; Dr. James E. Morrow and Dr. James Lindzey for guiding the project, offering helpful suggestions and for their critical review of the thesis; Dr. Albert W. Johnson and Dr. Leslie A. Viereck for identifying some of the plants and reviewing sections of this thesis; Dr. L. Gerard Swartz for identifying parasites found in mink from the study area; Dr. David M. Hopkins, Dr. Troy Péwé and Mrs. Florence Weber for their enlightening discussions and suggestions with respect to geology of the Delta; bush pilots John Samuelson Jr. and the late Gary Hodgins, for orientation and their logistic support; traders in the area including John Samuelson Sr., Jim Stevenson, Joe Mendola, George Sheppard and Keith Swanson, for their cooperation in many ways; and the people of Nunapitchuk and Kasigluk for attempting to teach a novice the ways of the tundra and providing interesting and informative company. Edward

and Michael Chase of Nunapitchuk and Oscar Beaver and Evon Albright of Kasigluk were especially helpful. The following Bureau of Indian Affairs teachers were very helpful: Mr. and Mrs. James Hinman, Mr. and Mrs. Bruce Crow, Mr. and Mrs. Duane Carlson and Mr. and Mrs. Roman Kinney, who on many occassions provided warm quarters and hot meals to an uncomfortable investigator; Mrs. Delores Tinjum for her helpful comments and typing of the final draft of this thesis.

Last, but most important, my wife Joyce deserves recognition for her encouragement throughout this study and for her efforts directed toward completing it. To her I am especially thankful.

Authorities for scientific nomenclature used in this thesis include: Anderson (1959), American Ornithologists' Union (1957), Fink (1960), Hall and Kelson (1959), Simpson (1945), and Wilimovsky (1958).

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INTRODUCTION

The large scale production of domestic mink throughout many sections of the United States and Canada has had its effect on the trapping industry by generally decreasing the demand for wild mink. With few exceptions, the price of wild mink from most areas of North America has declined steadily since World War II. An exception to this trend is the mink produced on the Yukon-Kuskokwim Delta of southwestern Alaska. Demands of French and Italian fur markets have placed these mink among the most valuable produced in North America today.

In recognition of the importance of the Yukon-Kuskokwim Delta mink, this study was originally initiated with the aims of trying to gather information on their ecology, working toward identifying and evaluating factors affecting production and harvest, and attempting an explanation of the reported marked fluctuations in abundance characteristic of mink in this region. During the course of study two additional points arose and have since become an integral part of this thesis. These are a discussion of certain taxonomic characters of mink from the Delta, and a discussion of the value and economic importance of the delta mink.

Eskimos inhabit the area, and almost one half of the total Alaskan population of these natives is found on this triangular Delta. These people are largely dependent upon fish and wildlife resources for their physical and economic well being. Surprisingly enough, there are only a few land mammals present which can be utilized, and the mink is by far the most important. Mink flesh is used as a food item, and pelts are used in the manufacture of home-made garments or as a source of income.

THE STUDY AREA

The project area includes all of the Yukon-Kuskokwim Delta and nearby Nelson and Nunivak Islands. It extends from 59° 45' north latitude to 62° 45' north latitude, and 161° 00' west longitude to 167° 30' west longitude. This study area is bounded on the north by the Illivit Mountains which closely border the Yukon River as far west as Mountain Village. From this point westward, the Yukon River Delta begins to fan out. The Kilbuk Mountains represent the southern boundary and extend almost to the Bering Sea near the village of Kwinhagak. Tuluksak, a village approximately 38 miles northeast of Bethel, represents the east boundary. Nunivak Island is the most westerly part of the area and is separated from the mainland by Etolin Strait. This study area includes a total area of approximately 23,000 square miles (Fig. 1).

Relative Relief

Almost 90 per cent of this is a lowland plain with numerous ponds and lakes ranging in size from a few yards to 15 + miles in length. This lowland plain is developed on unconsolidated materials. The remaining area is occupied by isolated island-like, barren, hilly masses closely underlain by bedrock. Relative relief throughout most of the lowland plain rarely exceeds 100 ft. The highest elevations occur in the Kusilvak Mountains which rise from almost sea level to 2,450 ft. (Coonrad, 1957).

Climate

The climate of this area is greatly influenced by the Bering Sea. Temperatures are lower during the summer months and higher during winter months than in interior Alaska. Weather stations in the area are

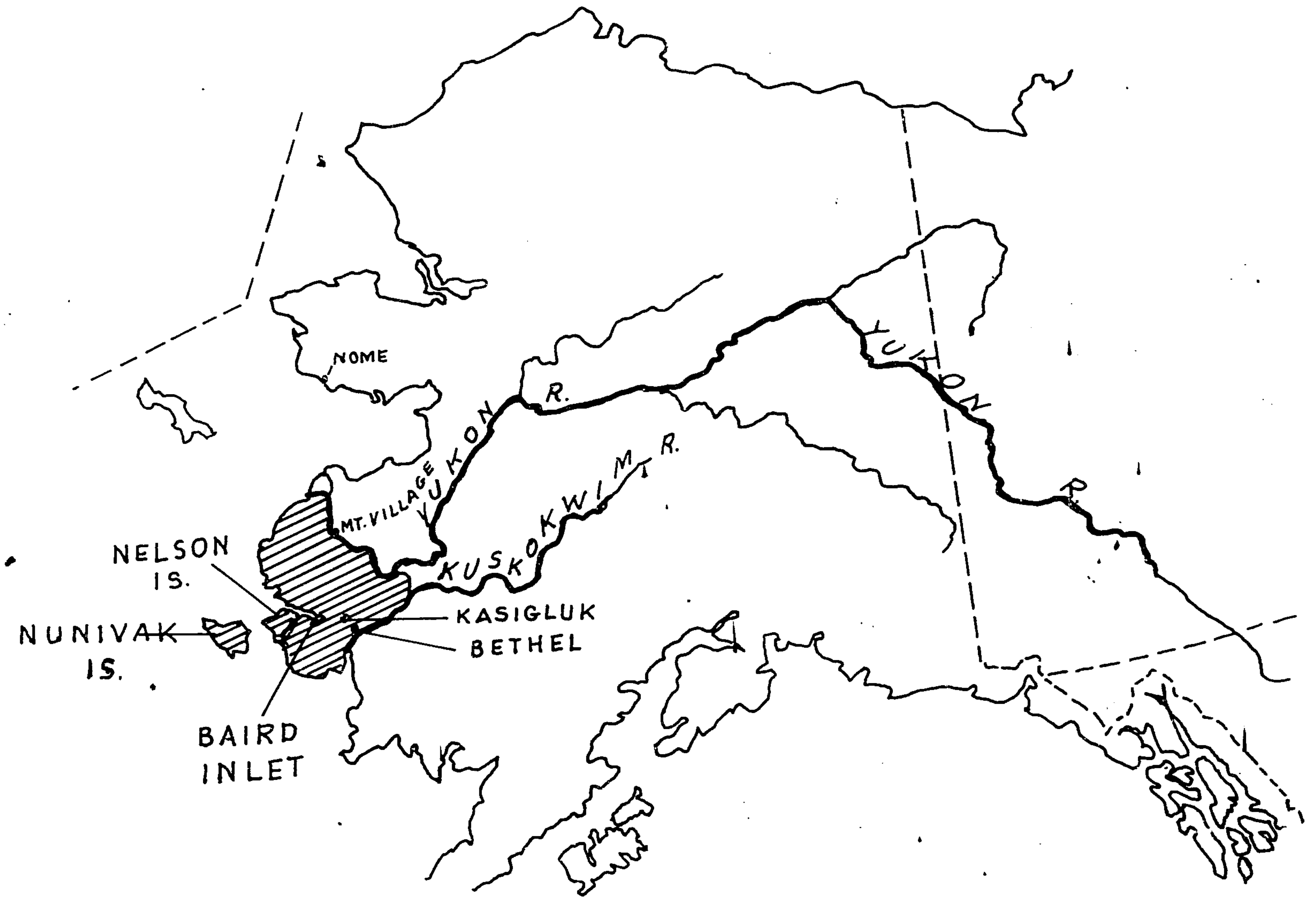


Fig. 1. Location of the Yukon-Kuskokwim Delta, and Nunivak Island, Alaska.

located at Bethel, Nunivak Island and Mountain Village. These stations border the study area, and all are influenced by bodies of water. The kinds of information recorded from each vary considerably and the data cannot be used as an accurate measure of actual conditions existing in inland areas of the Delta. They are however, useful for general descriptions of climate.

During 1959, the average January temperatures were highest at Nunivak Island. They decreased toward Mountain Village and Bethel. High temperatures in June occurred in the reverse order with Bethel recording the highest average, and Nunivak the lowest. These examples illustrate how proximity to the sea affects temperatures.

The greatest climatic differences in the area are in the amounts of precipitation. Amounts of precipitation decrease to the north and also, during summer months, are less toward the coast. During 1959, precipitation recorded at Bethel was 16.08 in.; 12.48 in. fell at Mountain Village, and an unrecorded amount occurred at Nunivak Island. Past records from Nunivak Island indicate that it has more precipitation during the winter and less during the summer than does Bethel or Mountain Village. Information from these stations is included to illustrate general climatic gradients existing between these points (Tables 1, 2 and 3).

Geology

Rock Units

Hoare (1952) states that rocks in the lower Kuskokwim Region range in age from Precambrian to Pliocene or Pleistocene. Gneiss or schist formed by the metamorphism of sedimentary and volcanic rocks are

Table 1.--Temperature, Precipitation, and Wind Readings at Bethel, Alaska, From January to December, 1959*

Month	Temperature (°F) Maximum	Temperature (°F) Minimum	Long Term Average	Precipitation (in.) Total	Precipitation (in.) Snowfall	Snow On Ground (in.)	Wind Velocity (mph) Average	Wind Velocity (mph) Maximum
January	36	-21	3.3	.23	2.5	3	17.8	38
February	36	-18	20.6	2.12	18.1	12	16.0	55
March	38	-27	-2.7	.41	5.5	16	12.3	32
April	44	-21	18.3	.86	7.0	16	15.4	38
May	68	26	42.1	.61	1.7	4	13.0	35
June	86	35	51.4	.85	0	0	11.8	32
July	68	31	50.5	1.35	0	0	14.3	35
August	77	35	54.4	4.94	0	0	14.1	36
September	62	27	44.9	2.36	1.3	T	12.2	44
October	51	4	28.0	.73	2.8	2	14.8	33
November	44	-3	21.4	1.03	5.3	3	15.4	40
December	26	-32	-7.6	.59	7.6	9	15.1	40
Total				16.08	35.51			

* Records compiled by U. S. Department of Commerce, Weather Bureau.

Table 2.--Temperature and Precipitation Readings for Nunivak Island, Alaska, From January to December, 1959*

Month	Temperature (°F) Maximum	Temperature (°F) Minimum	Long Term Average	Precipitation (in.) Total	Precipitation (in.) Snowfall	Snow On Ground (in.)
January	34	-10	13.4	.61	-[1]	7
February	36	1	23.9	.51	-	14
March	-	-	-	-	-	-
April	-	-	-	-	-	-
May	-	-	-	-	-	-
June	54	29	41.4	-	-	0
July	61	28	46.0	.84	0	0
August	65	32	50.9	1.48	0	0
September	55	-	46.5	-	0	0
October	52	24	34.5	.78	-	-
November	40	10	28.6	1.25	-	5
December	31	-20	3.9	1.20	-	10

* Records compiled by U. S. Department of Commerce, Weather Bureau.
[1]Indicates that no information was recorded.

Table 3.--Temperature and Precipitation Readings for Mountain Village, Alaska, From January to December, 1959*

Month	Temperature (°F) Maximum	Minimum	Long Term Average	Precipitation (in.) Total	Snowfall	Snow On Ground (in.)
January	28	-20	4.4	.39	-[1]	10
February	34	-17	19.1	.40	-	10
March	25	-26	-1.9	.14	-	10
April	40	-21	16.4	.07	-	10
May	68	26	40.9	.79	-	4
June	74	35	49.2	1.17	-	0
July	68	31	48.9	1.49	-	0
August	72	37	53.1	3.86	0	0
September	61	26	43.9	2.33	0	0
October	57	10	30.2	.63	-	2
November	36	-11	19.9	.88	-	12
December	24	-31	-7.7	.33	-	16
Totals				12.48		

*Records compiled by U. S. Department of Commerce, Weather Bureau.

[1]Indicates that no information was recorded.

thought to be of Precambrian age. Rocks of early Paleozoic age are largely limestone. Fine-grained clastic rock, chert, volcanic rock, and limestone represent the Permian and Triassic periods. According to Hoare (1952), these rocks were deposited under nonorogenic conditions and were derived from local submarine and subaerial volcanism and from a distant terrestrial source.

Coonrad (1957) states that the Cretaceous rocks on Nelson Island are predominantly graywacke-type sandstone and siltstone; there are minor amounts of calcarious siltstone, sandy pebble conglomerate, and thin coal beds. He based the age of these rocks on the identification of plant fossils and on their lithologic similiarity to rocks of known Cretaceous age. He also infers that the bedded rocks cropping out in the Kusilvak Mountains and the outcrops on Nunivak Island are of Cretaceous age.

The western part of the Yukon-Kuskokwim Delta is part of a discontinuous volcanic belt that extends from eastern Seward Peninsula southward along the Bering Sea to Nunivak Island and possibly to the Pribilof Islands. The numerous small cinder cones and lava sheets present in the Delta are composed of mafic volcanic rocks. Coonrad (1957) has divided the Delta region into five main areas of volcanic rock outcrops. These are Nunivak Island, Nelson Island, Kinia River, Ingakslugwat Hills and Ingichuak Hill.

Surficial Deposits

According to Coonrad (1957), the unconsolidated deposits on which the lake-pocked lowlands have developed include surficial deposits of silt, sand, gravel, and organic materials, ranging in age from early

Pleistocene to Recent. It is believed that the presence of highly modified cirques and U-shaped valleys in the higher parts of the Askinuk Mountains indicate possible sources of unconsolidated deposits of glacial origin. A large part of the Delta is mantled with loess, but extensive areas of alluvium, colluvium, and marine beach and lagunal deposits exist.

Important Geological Phenomena

Topographic features of any area and the geology of their formation are important as they often play a large part in determining the types of fauna and flora which will develop. Three geologic phenomena were recorded as playing important roles in the ecology of mink found in the Delta. These are the occurrence of permafrost, thaw lakes, and pingos.

Permafrost

The Yukon-Kuskokwim Delta lies in the zone of discontinous permafrost. This permafrost or perenially frozen ground (even without obvious ice) has a great influence on the fauna and flora of the area because of its influence on formation of thaw lakes, pingos, sink holes and polygonal ground patterns.

Muller (1947) defines permafrost as:

> A thickness of soil or other superficial deposit or even of bedrock, at a variable depth beneath the surface of the earth in which a temperature below freezing has existed continually for a long time (from two to tens of thousands of years).

He also defines two additional terms which will be helpful to this discussion: 1) permafrost table - that surface that represents the upper limit of permafrost; 2) active layer - the layer of ground above permafrost which thaws in summer and freezes again in winter. This layer may extend down to the permafrost table.

Permafrost probably first appeared at the beginning of the Pleistocene, perhaps a million years ago. Subsequent periods of climatic fluctuations produced corresponding changes in the thickness and extent of permafrost (Muller, 1947).

The ice content of silts similiar to those existing in the Yukon-Kuskokwim Delta may exceed 80 per cent by volume and will probably average over 50 per cent (Taber, 1943). Hopkins (1949) states that the porosity of similiar unfrozen silts would be 20 to 30 per cent. He also says that excess ice becomes segregated and forms clear ice lenses, wedges, and veinlets distrubuted through the sediment. Ice lenses and ice wedges are an important factor in the formation of pingos and polygonal ground patterns.

Annual differences in thermal relationships determine the depth to which the active layer will thaw during any given summer. The differences are caused by variation in cloud cover allowing solar radiation to penetrate to the ground, prevailing temperatures, precipitation, and the type of plant cover present.

According to a well driller in Bethel, permafrost occurs there to a depth of at least 400 feet. With respect to the ecology of mink on the Delta, it will be shown that permafrost is a physical factor controlling many environmental conditions.

Thaw Lakes

Permafrost conditions in the Delta have contributed to the development of systems of lakes, sloughs and rivers so numerous and complicated that they are a hazard to strangers traveling by boat (Fig. 2). Although little work has been done on the origin of lakes in this area, evidence

Fig. 2 The village of Nunapitchuk
and surrounding countryside.

indicates that many of them are the result of differential rates of thawing.

Lakes such as those in the Delta are commonly called "thaw lakes" and originate in areas of locally deep thawing which, according to Hopkins (1949), can take place in any of the following ways:

1. As the result of disruption of the vegetal cover by frost-heaving and subsidence of the resulting bare soil areas.

2. As the result of accelerated thaw beneath pools in small streams. Luxuriant vegetation or dams raised by frost-heaving create standing pools beneath which rapid thawing and subsidence take place. Small streams commonly consist of a series of such thaw pools connected by short, shallow water courses.

3. As the result of accelerated thaw beneath water occupying intersections of ice-wedge polygons. Once a pool of water becomes established it will usually enlarge.

Hopkins goes on to say:

> The presence of the lakes simply reflects the occurrence of a thawing season sufficiently long or warm to produce important differences in the depth of thaw in and beneath bodies of peat, mineral soil, or water.

Pingos

The term "frost-mounds"as used by Muller (1947) refers to mounds produced by frost action. They vary widely in size, structure, origin and duration. As in the case of lakes in the Delta, there has been very little work done on the frost-mounds.

Of the several hundred pingos I have observed in the Delta, all were of the closed-system type. Closed-system pingos, described in detail by

Muller (1959), have thus far been recorded only from areas of continuous permafrost. Like the closed-system pingos of more northern latitudes, those in the Delta usually occurred in shallow or drained lake basins (Fig. 3). Closed-system pingos result from the freezing or refreezing of water-rich ground, and from the segregation of contained interstitial water (Porsild, 1938).

Pingos in the Yukon-Kuskokwim Delta are circular, oval, elliptical or irregular in plan, 15 to 200 ft across, and usually less than 30 ft high. In profile they usually appear ovoid or conical. Older pingos are more plateau-like.

Cross sections of six pingos revealed a frozen core of two types. The cores of three relatively small (30 to 60 ft in diameter, less than 15 ft high), unstable, grass-covered pingos were lens shaped, and of frozen mud. The cores of three older and more stable pingos were lenses of ice, overlain by frozen mud.

Pingos in the Delta are used to a great extent by mink. In swampy areas such as exist on the north side of Baird Inlet and north of the villages of Kasigluk and Nunapitchuk, they are the only land features which provide suitable natal den sites for mink. A difference exists in the utilization of pingos by wildlife, depending on the type of vegetation that is present. As will be mentioned in a later section, there is a definite plant succession on newly established pingos. Another important factor in the utilization of these features by wildlife (waterfowl, mink and muskrats), is that they are surrounded by or adjacent to water.

Vegetation of Lowlands and Tundra

The Delta is a low, coastal plain, bearing many vegetation types

Fig. 3 A large pingo approximately 30 feet in height near Nunachuk, Alaska

depending upon differences in relief. There are extensive, low-lying, wet areas of marsh between Bethel and Baird Inlet, and near the mouth of the Yukon River. The following plants are abundant in these marshes: Menyanthes trifoliata, Caltha palustris, Petasites frigidus, Draba alpina, Polemonium acutiflorum, Carex aquatilis, Rumex sibiricus and Salix pulchra. Menyanthes trifoliata forms extensive floating mats in areas of stagnant or sluggish water. Equisetum variegatum occurs extensively along lake and stream borders.

Willows usually occupy ground which is slightly higher and better drained. They usually grow along streams where a high bank affords protection from abrasion by wind-driven snow. In areas close to the Kuskokwim River, alder (Alnus crispa) is found growing with the willows.

During spring and early summer many marshes are covered with water which becomes shallower as summer progresses.

Areas of greater relief support a completely different type of plant cover. The change from one type to another is striking and occurs with an increase of only a few inches in relief. Banks of water courses and thaw lakes are steep-sided and are most commonly between 1 and 10 ft in height. The higher areas are covered by the typical tundra plants including a thick mat of mosses (mostly Sphagnum spp. and Polytrichum spp.), lichens (Cladonia spp.), Empetrum nigrum, Ledum palustris decumbens, Rubus chamaemorus, Vaccinium vitis-idaea, Vaccinium uliginosum, Eriophorum angustifolium, Festuca altaica and, in some locations, Spiraea beauverdiana. This was the most common community type found on the higher sites. Frozen ground occurred closest to the surface under this type of vegetation, being within 4 to 8 inches.

Vegetation of Pingos

Pingos, which are numerous in the low lying areas of the Delta, exhibit a definite plant succession. In analyzing vegetation of these topographic features, it was found that they could be classed as one of three types depending upon the plant community they supported. The three types include a grass type, a mixed vegetation type, and a tundra type.

Secondary succession on pingos is caused by localized changes in relief, drainage, exposure, and ground ice conditions. The first plant to invade a growing pingo is Calamagrostis canadensis. This species was found on the smallest topographic features identified as growing pingos. The duration of dominance of this species apparently depends on the rate of accumulation of organic materials in the soil, and the stability of the pingo. While pingos are forming, they are comparatively unstable, and areas of extensive slumping are present. They are crisscrossed by deep cracks, particularly around the sides. Without exception, all pingos in this condition support communities composed almost entirely of C. canadensis (Fig. 4).

As the stability of pingos increases and more organic material becomes incorporated into the soil, a second species, Spiraea beauverdiana, becomes established. I have called pingos supporting this community type "mixed-vegetation pingos." The codominant plant species are Calamagrostis canadensis and Spiraea beauverdiana with the former declining as the latter becomes dominant. Pingos on which Calamagrostis canadensis and Spiraea beauverdiana occurred in combination were arbitrarily termed "mixed-vegetation pingos" if S. beauverdiana occupied 20 per cent or more of the total area. There were no cases observed in which S. beauverdiana occurred in pure stands occupying an entire pingo. The maximum observed coverage of this species on any one mound was 75 to 80 per cent. Other plants found on mixed-vegetation pingos include Angelica lucida, Artemisia tilesii, Petasites frigidus, and Epilobium angustifolium (Fig. 5).

The next important stage in the succession is the appearance of mosses and lichens. These plants come in under Spiraea beauverdiana. Perhaps S. beauverdiana is eliminated because its seeds do not reach mineral soil due to the presence of mosses and lichens. This insulating mat also permits the permafrost table to rise and this may eventually kill the root system of Spiraea.

When the thickness of the mat of mosses and lichens increases, other plants begin to invade. One of the first is Rubus chamaemorus. The sequence of other plants which follow is unclear, but the plants include Ledum palustris decumbens, Vaccinium vitis-idaea, Vaccinium uliginosum and other plants found on the higher tundra of surrounding areas.

Pingos assume the aspect of typical tundra, and all but the sloping sides are covered with tundra vegetation. Instability of the sides due to slumping and continued cracking disrupts the normal succession. Vegetation of these sites is of the grass type, or, in some cases, the mixed vegetation type (Fig. 6).

The occurrence of vegetation types under particular conditions on adjacent or asymmetrical pingos is an indication of factors affecting relative rates of succession.

Fig. 4 A grass type pingo approximately 15 ft high. The two major species are *Calamagrostis canadensis* on the pingo and *Carex aquatilis* in the foreground. Nunapitchuk, Alaska.

Fig. 5 Side of a mixed-vegetation type pingo showing the two codominant species *Calamagrostis canadensis* and *Spirea beauverdiana*. Nunapitchuk, Alaska.

Figure 7 shows an asymmetrical pingo on which the three community types occur. The grass community is not well developed and occurs only on areas of disturbance lacking a well formed litter layer. The mixed community occurs at the highest points on the pingo. Since the top is more stable than the sides, an accumulation of organic material in the soil could be expected. On this site, exposure to wind and blowing snow has apparently slowed down the succession but not to the same degree that cracking and slumping has. The actual reason or reasons for elimination of Calamagrostis canadensis is not known, but it is assumed that once Spiraea beauverdiana is established it can successfully compete with the grass.

The climax community, which in this succession is the local tundra type, occurs on the broad, more protected sides. It occurs here because of favorable conditions allowing for a more rapid succession on this site. In protected areas such as this, organic material accumulates more rapidly, and wind and snow do not exert the same degree of influence as they do on the more exposed sites. Eventually, tundra vegetation will occupy the major portion of the pingo. In this case, the broad flat side of the pingo shown in Figure 8 does not exhibit the slumping and cracking characteristic of the more curved sides of the same pingo.

Animals Present

Animals present in the Delta can be divided into two categories, those present throughout the year and those that are present only during the spring and summer. The first group includes Willow

Fig. 6 A tundra type pingo near Nunachuk, Alaska. Plants present include mosses (mostly _Sphagnum_ spp. and _Polytrichum_ spp), lichens (_Cladonia_ spp.), _Rubus chamaemorus_, _Empetrum nigrum_, _Ledum palustris decumbens_, _Spiraea beauverdiana_ and _Calamagrostis canadensis_.

Fig. 7 An asymmetrical pingo showing the occurrence of the three vegetation types illustrated in Figs. 5, 6, and 7. Nunvarnuk Lake, Alaska.

Ptarmigan[1], voles, shrews, muskrats, weasels, otter, beaver, red fox, mink, snowshoe hare, arctic hare, pike, nine-spined stickleback, blackfish, whitefish, and burbot.

Those present only during the mild part of the year include many species of birds, especially shorebirds and waterfowl. These include the Pintail, Greater Scaup, Shoveller, Mallard, Green-winged Teal, Oldsquaw, Bufflehead, American Scoter, Common Loon, Canvasback, Widgeon, Cackling Goose, White-fronted Goose, Pacific Brant, Common Eider, Sandhill Crane, Northern Phalarope, Red Phalarope, Wilson's Snipe, Bar-tailed Godwit, Black-bellied Plover, American Golden Plover, Ruddy Turnstone, Knot, Greater Yellowlegs, Least Sandpiper, Pectoral Sandpiper, Baird's Sandpiper, Semipalmated Sandpiper, Long-tailed Jaeger, Parasitic Jaeger, Glaucous-winged Gull, Mew Gull, Sabine's Gull, Arctic Tern, Savannah Sparrow and Violet-green Swallow. For more detailed information on birds in the area see Walkinshaw and Stophlet (1949), and Willamson (1957).

The most important fishes of the area are the migrant species, including king salmon, silver salmon, dog salmon, red salmon, pink salmon, sheefish, and smelt.

Seals and walruses are present along the coast, depending upon ice conditions, the largest numbers being taken during early spring and late fall.

Human Inhabitants of the Area

Most inhabitants of the Delta are Eskimos. As yet there are very few shite people, and those present are mostly

[1] Scientific names of animals are listed in Appendix B.

traders, teachers, missionaries, or in some way representing a government agency. Eskimos in this area are divided into five groups, which include the Nunivagmut, living on Nunivak Island and northwestern Nelson Island; Kaialioamut, living along the coast from Cape Romanzof approximately to the village of Chefornak; Magemut, inhabiting the area south and west of the Yukon River; and the Kuskokwagmut who live along the Kuskokwim River (Nelson, 1898).

Natives of the Delta commonly divide themselves into three general groups, the coast people, river people, and tundra people. The staple food items vary from sea mammals on the coast and salmon along the Yukon and Kuskokwim Rivers to whitefish, migratory birds, and blackfish for the tundra groups.

The ethnography and culture of these Eskimos are discussed at length by Nelson (1898), Lantis (1959) and Oswalt (1963). This thesis considers only the groups present in the immediate study area and the factors affecting their harvest of mink.

In the Delta, as well as throughout the rest of Alaska, the Eskimos are in the midst of a cultural change which affects many of their activities, including trapping. Formerly there were many more villages in the area than exist at present, and they were more widely dispersed throughout the Delta. Wide distribution of villages allowed greater coverage of the area, and there was less hunting pressure per unit of area, particularly considering the limited range of hunters using dog teams.

The operational range of hunters has remained the same, but owing to the consolidation of smaller villages into fewer, larger ones, there are more men hunting on a smaller area. The most important causes of consolidation were establishment of trading posts, schools, and churches.

With traplines, the situation is slightly different. A trapline or trapping area belongs to a man or, at most, to a small group of men. The lines are retained in the family, and when a man grows old his son usually takes over. Most traplines have remained where they originally were. Due to the consolidation of villages, traplines are often far from areas where trappers now reside. Other factors exist which further complicate the picture. Trapping previously was a family endeavor, but at present, children must remain in school. The woman of the household thus must also remain in the village. This situation creates conditions where men must provide quantities of wood to last their families while they are away, and trappers have the additional work at camp which was formerly done by women.

Frequent trips have to be made from traplines to villages in order to cut additional firewood and to do other chores.

Once home, trappers are often reluctant to return to their camps. This is one factor responsible for decreased trapping effort.

Another cultural change decreasing trapping effort is the fact that boys attending school are not learning how to trap. In many cases when they finish school they do not desire to spend two months at camps which, without the presence of a cook and housekeeper, leave much to be desired. They are also disinclined to accept the rigors of trapping as an alternative to the comforts of a wage earning way of life. Most men not engaged in trapping mink do little except daily chores during winter months.

Traditionally, mink are animals of relatively little value to these people. They are used to some extent as food, and pelts were used for making women's and children's parkas. It was not until the appearance of European and American traders that mink were trapped during the fall and winter. For home use, mink are usually captured during August when they are abundant and kits are easy to catch. At this time the leather is prime and fur is short, which is as the natives desire it. Garments are made with fur on the inside. The number of mink parkas observed indicates that this type of trapping is still practiced.

THE MINK: ITS CHARACTERISTICS AND BIOLOGY

To describe the Delta mink is to mention characteristics which make it one of the most valuable wild mink produced in North America. Mink from the Yukon-Kuskokwim Delta are large in size compared with those from other sections of Alaska. Adult males attain a length of about 650 mm while females are approximately 550 mm. Weights of entire, quickly killed, male mink caught during the 1961-1962 trapping season were as much as 2,010 g, while the weight of females was as much as 1,100 g. These weights are of mink caught in the vicinity of Dall Lake.

In winter-prime condition these mink are a dark chocolate brown in color with coarse guard hairs 2.5 to 3 cm in length. They are uniformly colored except for irregular white patches which occur on the chin, throat or belly. White patches are usually larger on females and often occur in the area of the mammary glands. Underfur is usually thick and wavy with an average length of approximately 1.5 cm, and is dark grey or light brown in color with a slight suggestion of light and dark bands. The tail is one fourth to one third of the total body length, with slightly longer and darker guard hairs, especially at the tip.

There is a great deal of uniformity in color among individuals, and the fact that large numbers of uniformly colored animals are available is another point contributing to their value. In comparison, mink taken from different drainages within localized areas of interior Alaska often exhibit differences in color which make them hard to match. Young mink observed during late August appeared slightly shorter than adult females and were more chunky with slightly lighter fur.

All mink observed moved rapidly but deliberately and they always appeared inquisitive. In a normal standing position they resemble an undulating serpent. This appearance is further amplified in these mink by their unusual length.

Classification

According to Simpson (1945), classification of this mink to genus is as follows:

Class Mammalia Linnaeus

Subclass Theria Parker and Haswell

Infraclass Eutheria Gill

Cohort Ferungulata Simpson

Superorder Ferae Linnaeus

Order Carnivora Bowdich

Suborder Fissipedia Blumenbach

Superfamily Canoidea Simpson

Family Mustelidae Swainson

Subfamily Mustelinae Gill

Genus Mustela Linnaeus [Including Putorius Frisch, 1775; Lutreola Wagner, 1841; Kolonocus Satunin, 1911]. Hall and Kelson (1959) continue this classification:

Subgenus Lutreola Wagner

Species vison Grey

Subspecies ingens Osgood

The type specimen of this subspecies is from Fort Yukon, Alaska. The subspecies ingens is found throughout Alaska north of the Alaska Range and east to Anderson River, Fort Good Hope and the Ogilvie Mountains in the Mackenzie District, Northwest Territories, Canada. Mink of this subspecies are noted for their size and heavy fur, particularly those of the Yukon-Kuskokwim Delta, the lower country of the Mackenzie River and the upper Yukon River country of Alaska and Canada.

Bee and Hall (1956) provisionally used the subspecific name ingens until such time as more specimens are available from areas north of the Brooks Range. Mink closely resembling those of the Delta are found on Nunivak Island and are here considered as belonging to the same subspecies.

Body Measurements of Delta Mink

Measurements of mink taken in the Delta during the 1960-1961 trapping season are presented in Table I of Appendix A. Recorded weights of most of these carcasses are of little value due to variation caused by different trapping methods and storage under dry, cold conditions. Measurements of length are accurate and are presented here as a source for comparative studies.

As an example of the large size of the Delta mink, the total lengths of 25 mink (of both sexes), from the Delta, were compared with the total lengths of 20 "timber" mink from the central Kuskokwim River area (from the vicinity of Aniak). The mean length of those from the Aniak area is 51.6 cm. The mean length of those from the Delta is 59.9 cm (a difference of almost 14 per cent). Mink from the vicinity of Ft. Yukon, Alaska, are only slightly smaller than those from the Yukon-Kuskokwim Delta. A more complete comparison of variation between Alaskan mink populations will be presented in a separate paper.

Distribution and Abundance

Mink occur throughout the Yukon and Kuskokwim River drainages, as far west as the mouths of the rivers, but the "Kuskokwim mink" locally known as "tundra mink" are found (as their name implies) on the tundra.

Topographic features which form the northern and southern boundaries of the Delta are generally the northern and southern limits of distribution except in the eastern portion where finger-like projections of muskeg and bog extend for some distance down both the Yukon and Kuskokwim Rivers. Both muskeg and bog are discussed in detail by Drury (1956).

Abundance of delta mink within the confines of the tundra-type community varies considerably with differences in habitat. Figure 8 shows the areas of high, medium and low mink abundance based on trapper reports and aerial surveys of habitat.

Two major areas have high mink densities. The first, and largest, is in the southwest section of the study area encompassing Nelson's (1898) "big lake country." This low, swampy terrain surrounds the largest bodies of water in the area: Baird Inlet; and Dall, Nunavakpak, Takslesluk, Nunavak, Anukslak, and Kyigayalik Lakes. The second, much smaller, area is located east of Scammon Bay, largely in the drainage of the Kashunuk River. Extensively interconnected water systems with large concentrations of blackfish and whitefish characterize both areas. Individual catches of mink in the Dall Lake-Baird Inlet area have been as high as 300 per year.

Areas of medium mink abundance (shown in Fig. 8) include that portion of the Delta extending from the Johnson River to the eastern edge of the tundra; the southern portion of the Delta to the foothills of the Kilbuk Mountains; the area from Owl Village on the Kashunuk River, to the margin of tundra along the Yukon River; the mouths of the Yukon River, except for the extensive tide flats; and the lower portions of Nelson Island.

Areas of low mink abundance include most of those portions of the Delta where the relative relief exceeds 100 feet, including an

Fig. 8. Areas of high, medium, and low mink abundance within the study area. From U.S. Geol. Surv., Alaska Map E.

Tolstoi Pt
St Michael
Stuart I
Pastol Bay
Pt Romanof
Nokogamiut
Kwiktokchi
Kogomiut
Krekatok I
Scammon Bay
Neragon I
Cape Romanzof
Igiak Bay
Dall Point
Hooper Bay
Hazen Bay
Baird Inlet
Etolin Strait
Cape Vancouver
Cape Etolin
Cape Manning
Cape Corwin
Cape Mendenhall
Cape Mohican
NUNIVAK I
Cape Avinof
Cape Kialegak
Southeast Cape
Punuk Is
HIGH
MEDIUM
LOW

area extending from the central part of the Delta eastward to Phillips, the higher areas of Nelson Island, Askinuk and other volcanic mountains, and the areas closely adjacent to the coast and both the Yukon and Kuskokwim Rivers.

Mink have not previously been recorded as being present on Nunivak Island, although it is quite certain that many visitors to the area were aware of their presence. According to local trappers from Mekoryuk, mink are present in low to medium abundance on the southern and eastern sides of the Island. The trapping pressure is relatively low as none of the men have long traplines, or spend much time at camps. The combined seasonal catch of trappers on Nunivak Island ranges from 50 to 150 mink.

Food Habits

The number of different kinds of food available to mink in the Delta is small compared with other regions, and in many cases seasonal abundance is very striking. Mink, like most predaceous mammals, are opportunists and usually take advantage of any situation which may provide an easy meal. Availability, which is usually a function of abundance, determines the extent to which a prey species will be utilized by mink. Information obtained from 20 fall-caught mink and from examination of summer and fall scats points out the seasonal changes in diet.

Figure 9 shows food items that are present, their period of highest availability and comparative abundance. It should be kept in mind that although a prey species must be present in an area

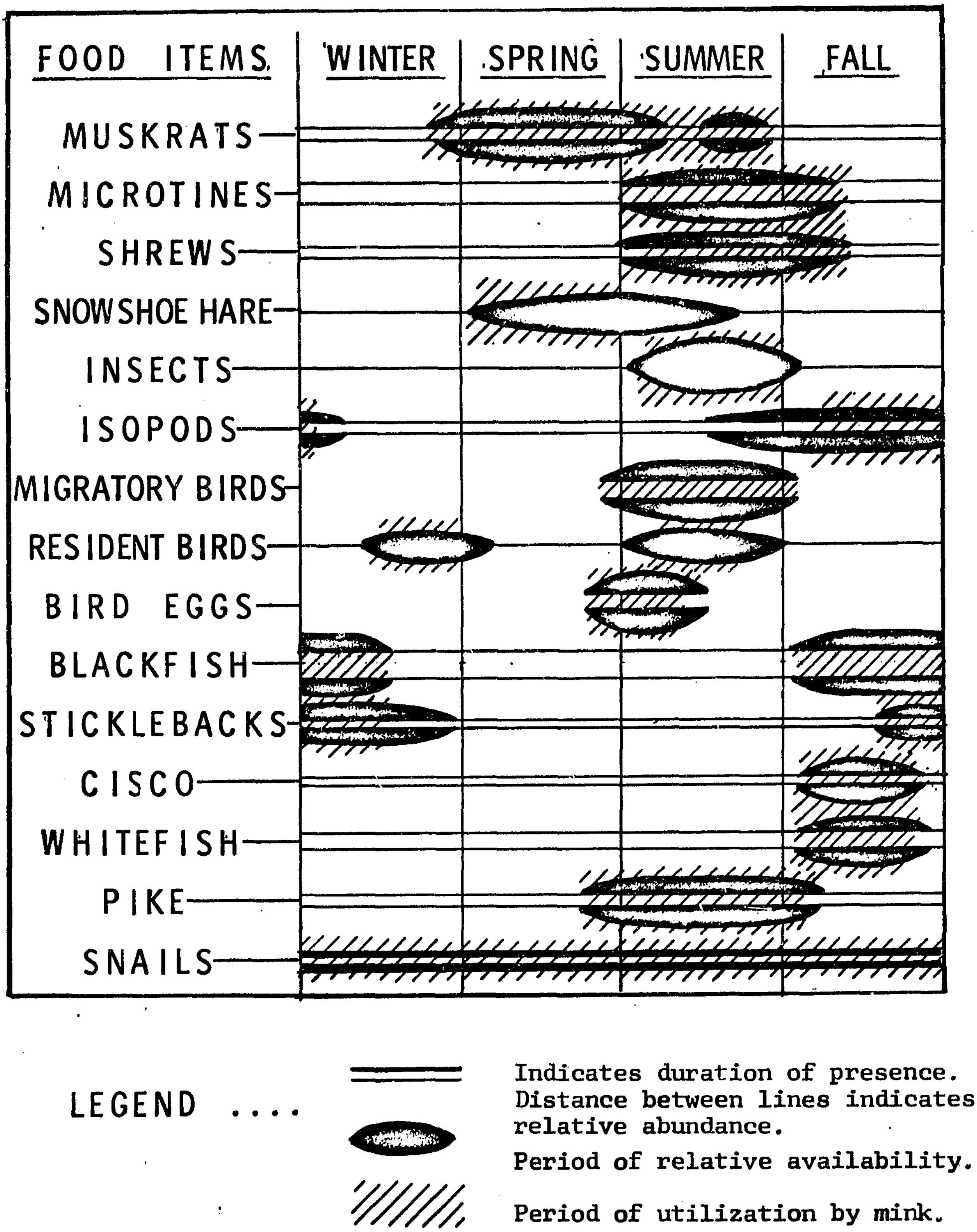


Fig. 9. Major food items of mink in the Yukon-Kuskokwim Delta, Alaska.

before it is available to mink, presence alone even in relatively large numbers does not necessarily mean it is readily available. As an example, blackfish (Dallia pectoralis) and muskrats (Ondatra zibethicus) were both abundant during the fall of 1961, but blackfish were taken more frequently than muskrats. Although muskrats were present in large numbers, the fact that they are more difficult to kill than blackfish would probably make them less available even if the biomass of these two prey species were relatively the same (which it is not).

Information from trappers in the area indicates that the greatest predation upon muskrats occurs during late winter and spring. At this time of year blackfish, sticklebacks (Pungitius pungitius), and whitefish (Coregonus spp.) are not very numerous in the small sloughs and streams and are no longer an easily available food source. During spring, absence of other prey species increases utilization of muskrats and low water conditions coupled with increased muskrat activity during breeding season make them particularly vulnerable. Errington (1954) points out that in central Iowa the incidence of muskrat remains in mink scats deposited during the colder months of the year was about three times that of the warmer months. Dearborn (1932), Sealander (1943) and Hamilton (1940) found muskrats to be an important food of mink in Michigan and New York. Sealander showed that male mink consumed more muskrats than did females, and suggested that "the size of a mink may determine the size of its prey." Wilson (1954) implies that in coastal North Carolina, where mink are relatively small and the muskrats large, there is a tendency on the part of mink to avoid strenuous conflict with muskrats, and they are a minor fall-winter food of mink. With respect to comparative size the reverse condition is true in the Yukon-Kuskokwim Delta. The average weight of 15 unskinned mink carcasses from the Delta was 1,456 g compared to the 700 g average of 25 muskrats.

Another factor influencing utilization by mink is fluctuation in the abundance of a prey species. Some species which are periodically abundant in this area include snowshoe hares (Lepus americanus), tundra voles (Microtus oeconomus), and to a lesser extent muskrats. Cowan (1948) found that in the Mackenzie Delta of northwest Canada the varying hare was the most important single food item of mink, followed by Microtus pennsylvanicus and Lemmus trimucronatus.

In the Yukon-Kuskokwim Delta the tundra voles are heavily preyed upon by mink during the summer months, at least in years when they are abundant. Apparently conditions associated with winter decrease their availability as the frequency of occurrence is much less in mink scats deposited in fall and early winter.

Throughout the period of this study snowshoe hare populations were extremely low and there was no indication of their use by mink. According to local natives, when hares are abundant they are most frequently taken by mink during early spring, when the hares are concentrated along rivers, and during the period when the young hares are born.

Migratory and resident bird species and their eggs are available during the time they are nesting, and it was found that eggs were commonly taken by both mink and weasels (Mustela erminea).

Isopods (Acelous sp.), blackfish, sticklebacks, and whitefish are available during the fall, at which time they are found in large numbers in the streams and sloughs. They become less numerous as fall progresses and are apparently moving into the deeper lakes and rivers.

During the first two weeks of November, 1961, six observations of mink and seven of otter (Lutra canadensis)were made as the animals were actively fishing. The first observation was made on November 7 when a pair of mink was seen going into a small area of open water at the outlet of a large lake. While the mink were under water, a trapper and I crept to the edge of the lake. One of the mink, a large male, surfaced but immediately dived. After a short period of time a female crawled out on the ice with a live cisco about seven inches long in its mouth. The mink was shot and examination of the fish showed that it had been paralyzed by being bitten immediately behind the head.

The second observation was of a large male mink which was coming up an open water slough toward us. About 200 yards from us the mink stopped and went into the water, coming out shortly with a medium sized blackfish, which was eaten whole. The mink then proceeded toward us at a mustelid gallop and stopped approximately 30 yards from our dog team.

The remaining four observations of mink were essentially the same as the second except that a heavy snowfall had covered the open water area with a thick layer of slush. Instead of crawling out on the edge of solid ice, the mink entered and came out of the water through holes they had pushed through the slush. Three of these mink were feeding on blackfish and one, observed at the outlet of a large lake, was feeding on small sticklebacks.

Northern pike (Esox lucius) are taken during summer months when they are found in the shallow water close to shore. During the summers of 1960 and 1961 several observations were made of small pike (10 to 14 inches in length), which were partially eaten by mink.

Snails, which are present throughout the year, were found in both summer and fall scats and it is assumed that they are eaten by mink throughout the year.

Stomach and Scat Analysis

Many of the usual problems encountered in stomach and scat analysis were minimized for two reasons: 1) because of the large expanses of homogenous habitat; 2) because of the reduced number of prey species available. In the comparison of stomach contents and scats (Table 4) the major reason for the discrepancy in frequency of occurrence, particularly of isopods and fish, is thought to be the small sample size. Differential digestive rates would also affect the comparison. In this case the rapid digestion of isopods and small fish (not larger fish like whitefish) would remove them from the stomachs more rapidly than the hair, skin and bones of mammals.

Table 5 is a comparison of scats collected at different times of the year. It illustrates the marked change in seasonal feeding habits of delta mink. During the summer, mammals and birds are the most important food items, while during the fall, fish are most important.

Breeding Habits

Compared with many mammals mink have a rather restricted breeding season, with ovulation and spermatogenesis occurring between late February and early May (Enders, 1952). Hammond (1953) found that photoperiod

Table 4.--Fall Food of Mink in the Yukon-Kuskokwim Delta, Alaska, Based on Contents of 20 Stomachs and 23 Scats

Food Item	Frequency of Occurrence			
	Digestive Tract	Per Cent	Scat	Per Cent
Mammals (total)	5	25	6	26
Muskrat	3	15	4	17
Vole	3	15	2	9
Shrew	-	--	-	--
Snowshoe Hare	-	--	-	--
Insects (total)	-	--	-	--
Isopods (total)	2	10	7	30
Birds (total)	-	--	1	4
Large	-	--	1	4
Small	-	--	-	--
Fish (total)	13	65	20	87
Blackfish	10	50	13	57
Sticklebacks	3	15	5	22
Cisco	1	5	2	9
Whitefish	1	5	1	4
Pike	-	--	-	--
Snails (total)	5	25	11	48
Vegetation Debris	7	35	11	48

Table 5.--Comparison of 23 Fall and 32 Summer Scats Collected in the Yukon-Kuskokwim Delta, Alaska, During 1961

	Frequency of Occurrence			
	Fall (23 scats)		Summer (32 scats)	
Food Item	Number	Per Cent	Number	Per Cent
Mammals (total)	6	26	30	94
Muskrat	4	17	7	27
Vole	2	9	25	78
Shrew	-	--	--	--
Snowshoe Hare	-	--	--	--
Insects (total)	-	--	3	9
Isopods (total)	7	30	1	3
Birds (total)	1	4	10	31
Large	1	4	7	22
Small	-	--	3	9
Fish (total)	20	87	6	19
Blackfish	13	57	6	19
Sticklebacks	5	22	--	--
Cisco	2	9	--	--
Pike	-	--	1	3
Whitefish	1	4	--	--
Snails (total)	11	48	10	31
Vegetation Debris	11	48	12	38

influences the estrous cycle of mink in that decreasing day length caused a delayed response. Enders (1952) states: "Genetic constitution appears to be a determining factor of the date of estrus. 'Yukon' mink are said to breed about 2 weeks later than 'Quebec' or 'Eastern' mink, but individual variation is often greater than this." According to Travis and Schaible (n.d.) once eggs are shed in ovulation it takes 6 or 7 days for another set capable of being fertilized to develop. Marshall (1936) describes the mating behavior as promiscuous, implying polygamy and possible polyandry under wild conditions. Young within a litter can be the result of fertilization by different males (superfecundation) and/or two different ovulations more than a week apart (superfetation). LaBeree (1941) indicates that in southern Ontario, mating begins during the first week of March for Quebec types and on the fifteenth for Alaskan and Yukon types.

John Samuelson (viva voce) said he had successfully raised and bred Kuskokwim mink which he live-trapped while he was living in Nunapitchuk (60° 53' N., 162° 25' W.). According to him, these mink mated during April; no exact dates were given. His statement lends support to the contention that mink of northern latitudes breed at a later date than their southern counterparts.

Travis and Schaible (n.d.) report the gestation period as 38 to 76 days while Enders (1952) stated that pregnancy lasts 40 to 75 days. Enders goes on to say that the length of gestation varies with the date of insemination, the longer periods being associated with early ovulation and insemination. The mean gestation period is about 51 days (Bowness, 1942; Kellogg _et al._, 1948; Travis and Schaible, n.d.). Embryonic attachment is for a period of 30 to 32 days regardless of date of breeding (Travis and Schaible, n.d.). Variation in gestation period occurs mainly due to the length of the period of implantation, making welping dates more closely grouped than breeding dates.

Samuelson (_viva voce_) said that kits of Kuskokwim mink were born during June. Assuming the average gestation period to be 51 days, a female mink bred on April 25 would welp on June 15. If the period of embryonic attachment is 30 to 32 days, then the period during which the developing embryo is unattached is 17 to 19 days.

Harbo (1958) found that the middle of June is the approximate time that young mink are born in the Huslia area of interior Alaska. His findings coincide closely with the information given by Mr. Samuelson.

During the summer of 1961, live-trapping operations were discontinued on July 28, due to unfavorable weather and travelling conditions. By that time no captures or observations of juvenile mink had been made, although traps were placed near active dens. The capture and observation of juvenile mink would not be possible until they emerged from their dens in early August. Field data concerning the size of mink litters in the Delta were not obtained.

Natal Den Sites and Their Ecology

Observations of natal den sites were made during the summers of 1960 and 1961 in three widely separated areas. The area of most intensive work was in the vicinity of Nunapitchuk. The other areas were on the northeast side of Baird Inlet (approximately 60° 50' N., 162° 45' W.), and in the vicinity of Mountain Village on the lower

Yukon River.

There was a high degree of similiarity in topographic and plant forms in the vicinity of natal dens.

Differences in topographic features between the area near Kasigluk and Nunapitchuk, and the area north of Baird Inlet created slight differences in selection of den sites. The area around Nunapitchuk is a large expanse of low swampy and marshy terrain. Banks of lakes and streams are low, and in many cases the only thing separating one lake from another is a stand of emergent vegetation with one or more channels winding through it. This area gives the impression of having been a very large body of water presently undergoing change. It is in this area that pingos are most abundant and are heavily utilized as den sites. West of this area, toward Baird Inlet, the lakes and sloughs are well defined by steep-sided banks often 15 ft high, and there are many areas above the summer high water levels in which mink can den. The number of pingos present in this area is comparatively small.

Table 6 is a summary of data on 18 natal dens which were active during the summers of 1960 or 1961. Those discovered during November, 1961, were classed as natal dens of the previous summer on the basis of scats present, heavy use of runs over a period of time, and wear on adjacent roots and stems of bushes.

In both areas mink dens, active and inactive, were most commonly situated in bushy type vegetation such as <u>Salix</u> spp. or <u>Spiraea beauverdiana</u>.

Marshall (1936), in his work on the winter activities of mink in Michigan, located 16 dens suitable for mink, all of which were under the roots of trees. Harbo (1958) found that at Huslia, Alaska, mink

Table 6.--Observations of 18 Natal Mink Dens Active During the Summer of 1960 or 1961 In the Yukon-Kuskokwim Delta, Alaska

General Location	Topographic Feature	Dominant Plants	Date
Kasigluk	Peninsula on lake	Salix and Calamagrostis	2 July, 1960
Kasigluk	Pingo bordering lake	Spiraea & Calamagrostis	2 July, 1960
Nunapitchuk	Bank of slough	Salix and Calamagrostis	6 August, 1960
S of Nunapitchuk	Pingo bordering lake	Spiraea & Calamagrostis	12 August, 1960
NW of Nunapitchuk	Pingo bordering lake	Spiraea & Calamagrostis	20 August, 1960
Kasigluk River	High bank	Salix and Calamagrostis	8 June, 1961
Kasigluk River	High bank	Salix and Calamagrostis	8 June, 1961
Nunachuk	Pingo bordering lake	Spiraea & Calamagrostis	15 June, 1961
Nunapitchuk	Pingo bordering lake	Spiraea & Calamagrostis	26 June, 1961
Nunapitchuk	Pingo bordering lake	Spiraea & Calmagrostis	26 June, 1961
Nunapitchuk	Pingo bordering lake	Spiraea & Calmagrostis	27 June, 1961
Nunachuk	Pingo bordering lake	Spiraea & Calamagrostis	27 June, 1961
Mountain Village	Bank of stream	Salix & Calamagrostis	5 July, 1961
Nunachuk	Pingo bordering lake	Spiraea & Calamagrostis	7 July, 1961
Nunachuk	Pingo bordering lake	Spiraea & Calamagrostis	11 July, 1961
20 mi W Kasigluk	High lake shore	Spiraea & Calamagrostis	11 November, 1961
NE side Baird Inlet	Bank of stream	Dense Salix	14 November, 1961
NE side Baird Inlet	Pingo bordering lake	Spiraea & Calamagrostis	19 November 1961

were quite adaptable, with respect to selection of den sites, and they utilized root systems of trees, abandoned beaver houses, and brush piles.

All active dens in the Delta were found under root systems of either Salix spp. or Spiraea beauverdiana. No reasons were advanced by Marshall or Harbo for the preference of sites under roots of bushes or trees, but there appear to be some definite correlations present in the Delta.

As stated earlier, the Delta is underlain by a thick layer of permafrost which comes very close to the surface especially under certain types of vegetation. Measurements of this depth were taken periodically from July 7 to July 17, 1961. During this time little if any change was noted. Permafrost came closest to the surface, ranging in depth from 4 to 13 in., under tundra-type vegetation (refer to section on vegetation) with its thick mat of mosses and lichens. In the majority of cases permafrost was found about 7 in. below the ground surface. On tundra-type pingos depth was only slightly deeper, averaging 8 in.

On grass-covered pingos, depth to frozen ground ranged from 6 to 12 in. On most pingos of this type it was about 11 in. Grassy pingos had a thick litter layer which was usually saturated. Many holes utilized by mink were found on these pingos, but no natal dens were observed.

Mixed-vegetation-type pingos consistently had the greatest depth to grozen ground. Depth ranged from 8 to 18 in., with about 17 in. occurring on the majority of pingos having active dens. This type of plant cover afforded other advantages besides deep unfrozen soil. A crude test to find relative saturation of soil (squeezing a handful of soil to determine friability) indicated that soil was most friable under both <u>Salix</u> spp. and <u>Spiraea beauverdiana</u>. Root systems extended further into soil under both of these plant covers, probably accounting for increased friability due to removal of soil moisture to a greater depth. The roots also impart stability to subterranean tunnels.

Bank dens were usually under willows, as <u>Spiraea</u> did not normally occur along borders of streams or lakes. Conditions similiar to those found under <u>Spiraea</u> also occurred under willows, except that depth to frozen ground was slightly greater. Areas overlain with tundra-type vegetation did not make suitable den sites due to shallowness of the thawed soil layer.

The number of possible natal den sites seemed almost unlimited, as suitable holes occurred in almost every location having a willow or <u>Spiraea</u> cover. Most of them appeared to have been used at one time or another by mink.

None of the mink dens observed showed signs of recent digging. It is assumed that in most cases, burrows used by mink were constructed by muskrats. Holes, once dug, seem to last for a long time.

Winter Dens

Several previously active dens were located during November, 1961. Two of nine observed were apparently natal dens of the past summer. A juvenile female mink was taken from one of these dens. Winter dens which showed the most use were also found in stands of <u>Spiraea</u> and willow. A possible explanation for this preference may lie in the fact that while most areas were blown free of snow, both willows and <u>Spiraea</u> caught and held it. The thick mantle of snow held by these plants probably affords mink some protection from the elements as is the case with many smaller mammals of the tundra.

Sex and Age Ratios of Trapped Mink

Petrides (1950) points out that ratios of sex and age may be useful measures of breeding success, relative mortality rates and other aspects of population fluctuations. There are various means of determining the age and sex of mink by pelt and carcass examinations. Several methods described in the literature have definite application to this study, while others seem to be of little value. Mink caught during the 1960-1961 trapping season were sexed from pelts and carcasses. Pelts alone were the only means of sexing mink caught during the 1961-1962 trapping season. The age of mink caught during the 1960-1961 trapping season was determined from carcasses. No age determinations were made on the 1961-1962 harvest.

Use of Pelts for Sex Determination

Sex can be determined easily in mink pelts by the presence or absence of a penile scar. Presence of mammary nipples on female pelts is a secondary, usually unneeded, indicator (Petrides, 1950). In areas such as Alaska where most pelts are sold with fur side turned out, the penile scar can usually be felt by moving a hand down the ventral midline of the pelt. In this manner, large numbers of skins can be sexed in a relatively short period of time. Care must be taken in handling pelts which have been stretched improperly or off center. On these pelts mammary nipples of females, particularly adults, can easily be mistaken for a penile scar. Doubtful pelts can be properly identified as to sex by looking into the cased skin for a penile scar.

Pelts of females are usually smaller, less leathery and have silkier fur than those of males, particularly in delta mink which have comparatively leathery hides. In the majority of instances pelts separated according to size and texture are also correctly segregated with respect to sex.

Results of Two Year Study

Mink pelts were checked for sex during both 1960-1961 and 1961-1962 trapping seasons. Results show some interesting differences in sex ratios which can be attributed directly to the mechanics of trapping in the Delta, and to the varying abundance of mink.

The examination of pelts during both 1960 and 1961 was made just prior to the Christmas Holidays. By this time of year, most trappers have traded or sold their pelts, and the traders still have them on hand. Christmas normally marks the end of the trapping period unless unusually favorable weather conditions, or high concentrations of mink, exist (situations occurring neither in 1960 nor 1961). It is felt that the samples obtained allow fairly accurate estimates of the catch, and its characteristics.

In December, 1960, 1,349 mink pelts were examined. Of these, 799 were males and 550 females (59.3 per cent males, 40.7 per cent females). This sample represents approximately 14 per cent of the total harvest. During the same period in 1961, 1,245 pelts were examined. Of these 836 were males and 409 were females (67.2 per cent males, 32.8 per cent females). The harvest of mink during 1961-1962 trapping season was poor and probably did not exceed 7,000 pelts. Assuming a harvest of 7,000 pelts, the December, 1961, sample represents approximately 18 per cent of the total harvest.

Differences in sex ratios between 145 males: 100 females caught during the 1960-1961 trapping season, and 204 males: 100 females caught during the 1961-1962 trapping season (Chi-square=39.22) can be explained on the basis of trapping pressure and duration of trapping period as affected by abundance of mink. Under normal trapping conditions more males than females are caught during the early part of the season. This is due to the larger area of activity of males, which increases their chances of finding sets (Yeager, 1950). Greer (1956) and Quick (1956) found that with marten there was a progressive decline in the proportion of males as the trapping season progressed. This seems to be due to a combination of factors including a decreasing number of males in the population and a growing food scarcity in late winter which leads the females to range more widely (Yeager, 1950). Hence, if for some reason the trapping period is shortened, the harvest will be composed of animals caught early in the season, mostly males.

The 1961-1962 trapping season was one of relatively low production due to low mink abundance. All but the most avid mink trappers stopped trapping early. Thus, female mink that normally comprise much of the late season catch were not taken. It would seem that this works to the advantage of the mink population in that many of the females not taken are available to produce young the following spring. With this situation the population recovery rate would be more rapid if suitable conditions existed during breeding seasons following short trapping seasons.

Use of Pelts for Age Determination

Petrides (1950) found that differences in the size of mammary nipples permit the pelts of females to be separated into two age groups, juvenile and adult. Nipples of juveniles are smaller than 1 mm in diameter, scarcely raised, and not pigmented.

However the combined effects of the technique of pelt preparation and the poor conditions under which examinations were made during the study rendered Petrides' criteria useless. Regarding males Petrides states: "Other than the small size and thin skin of young individuals, no characteristic of pelt indicated age in males."

Use of Carcasses for Sex Determination

Sex determination from entire carcasses presented no problem. Most skulls of mink taken in November and December could be separated according to sex by conformation. The skull measurements used by Hall (1951) were made on 70 mink skulls obtained from the Delta. Even with this small sample, it was found that several measurements could be used as a basis for ascertaining sex when only skulls were available. The measurements found to be of use in this study were described by Hall (1951) as follows:

> Basilar length (of Hensel). -From the anterior-most border of the foramen magnum to a line connecting the posterior margins of the alveoli of the first upper incisors.
>
> Length of tooth-rows. -Least distance between a line connecting posterior borders of upper molars and a line connecting anterior faces of middle upper incisors.
>
> Depth of skull at anterior margin of basioccipital.- Measured from anterior end of ventral face of basioccipital, excluding median ridge, vertically to dorsal face of parietal excluding sagittal crest.

The most useful of these measurements are the basilar length (of Hensel), and the length of tooth-rows. Table 7 shows the sexual differences in these measurements.

Table 7.--Basilar Length, and Length of Tooth-rows of Mink Caught During the 1961 Trapping Season in the Yukon-Kuskokwim Delta, Alaska

Sex	N	Basilar Length (of Hensel), mm		Error Using 63 mm Sep. No. Skull	(%)	Length of Tooth-rows, mm		Error Using 25 mm Sep. No. Skulls	(%)
M	37	Max.	70.5	0	(0%)	Max.	27.6	1	(2%)
		Min.	63.3			Min.	24.9		
		$\bar{X}$	66.3			$\bar{X}$	26.0		
		S^2	3.73			S^2	9.47		
		$S_{\bar{x}}$	.31			$S_{\bar{x}}$	.51		
F	33	Max.	63.2	1	(2%)	Max.	24.9	0	(0%)
		Min.	57.4			Min.	22.3		
		$\bar{X}$	60.1			$\bar{X}$	23.6		
		S^2	2.73			S^2	7.42		
		$S_{\bar{x}}$	.29			$S_{\bar{x}}$	.47		

In the sample of 70 skulls separated on the basis of basilar length, only one female was incorrectly classified using 63 mm to divide the larger males from the smaller females. This resulted in an accuracy of 100 per cent for determination of males, and 98.6 per cent for females. Basilar length of the female incorrectly classed was 63.2 mm.

Length of tooth-rows proved to be of equal accuracy in determining sex. An arbitrary value of 25.0 mm was established as differentiating males from females. Using this value, one was incorrectly classified as a female. The length of the tooth-row for this specimen was 24.9 mm, closely approximating the arbitrarily established limit.

Depth of skull at the anterior margin of basioccipital was also of some value in separating the sexes, but it did not prove to be as accurate as the above mentioned methods. The mean depth of skulls for male mink was 22.0 mm, with a range from 20.5 mm to 23.0 mm. The mean depth of skulls for females was 20.7 mm, with a range of from 19.3 mm to 23.2 mm.

The chance of erroneously classifying adult males on the basis of skull depth increases since the skull shrinks in old age. This phenomenon will be discussed more fully later.

Sexing mink from skulls alone is very useful in areas like the Delta where carcasses are used as food for dogs and humans. It is much easier to obtain skulls than entire carcasses.

The major shortcomings of these methods are that skulls require preparation, and the methods described are applicable only after the values for separating the sexes are established. The values will vary with different mink populations, due to geographical variation in size.

Use of Carcasses for Age Determination

Several methods have been developed for determining age of mink and other mustelids, using various parts of the carcass. Petrides (1950) mentions the greater distance between canine teeth, greater tooth wear, and the increased development of sagittal crest as means of segregating adults from juveniles. One of the most accurate means of determining age of male mink involves examination of the baculum . Lechleitner (1954) mentions that these two age groups can be separated on the basis of baculum conformation alone. This method of determining age in male mink is probably the most widely used by wildlife biologists.

Petrides (1950) discusses differences in bacula as a method of determining age in mink. According to Petrides, bacula of adults are thicker and heavier in weight than those of juveniles, and can also be identified by the enlarged basal portions which are encircled near the end by an obvious ridge. Wright (1950), also indicates changes during the baculum's development which make it useful as a criterion of age. Observing the distinction between bacula of immature and mature weasels, he considered the possibility that baculum growth was stimulated by increased production of androgens during the breeding season. He tested this theory by castrating several immature animals and found that they did not develop bacula characteristic of adults. He then implanted pellets of testosterone propionate in castrated males, whereupon the bacula grew to adult size. Bacula of animals castrated as adults showed no regression.

Greer (1957) mentions several other osteological characteristics which are of value in determining age of mink including the presence or absence of the supra-sesamoid tubercle of the femur and presence or absence of the jugal-squamosal suture.

In the present study, age of mink was determined on the basis of baculum conformation (males) and the presence or absence of the jugal-squamosal suture (females). Females were classed as juvenile if the suture was present, and adult if it was absent. Although baculum conformation was used as the final criterion for age determination in males, there were no discrepancies when age was determined on the basis of presence or absence of the jugal-squamosal suture.

The sample from the Delta included 37 males (six adults and 31 juveniles). The mean weight of bacula from adults was 592.6 mg, while the mean weight of those of juveniles was 168.0 mg. The 95 per cent confidence intervals for these means are $\pm$ 134.7 and $\pm$ 10.1 respectively. The complete agreement between baculum conformation (and weight), and the jugal-squamosal suture as age indicators in males, is suggestive of the accuracy of the presence or absence of the suture for age determination of females.

Decreasing cranial size in old age animals has been noted by various authors, including Augier (1932), DeBeer (1937) and Pruitt (1954). According to Augier (1932) skull shrinkage in man may be attributed to a decrease in volume of the brain with a corresponding erosion of bone on the internal surface. Pruitt (1954) suggests that broadening of the head in Sorex cinereus may be due to an increase in muscle volume since the skull itself may actually shrink with age. This shrinkage may be due to erosion by muscle action. He goes on to say, "A common example of this action is the erosion of the scapula in the region of the infraspinatus fossa in some old, hard-worked horses."

Present data indicate that the depth of skulls at the anterior margin of the basioccipital decreases as the age of the mink increases. The mean depth of the skull at this point in six adult males, was 20.6 mm ($S^2 = .1925$, $S = .439$) while that of 31 juvenile males was 22.3 mm ($S^2 = .2870$, $S = .536$). Without a sample of known-age wild mink, there is no means of finding the rate of decrease in depth of the skull. It is my opinion that skulls of ranch mink are not suitable for determining the rate of bone erosion as it is decreased due to restricted activity and food requiring little if any mastication.

Pelt Primeness

In general, pelt primeness is defined as the condition and appearance of pelts when leather prime and fur prime conditions occur simultaneously. During the trapping seasons of 1960-1961 and 1961-1962 this condition occurred in male mink by November 20 (by November 16 in 20 of 24 pelts examined specifically for primeness). Female mink were also prime by November 20 but were usually later than males; eight of 16 examined were completely prime by November 16. Pelt quality begins to deteriorate shortly after primeness is attained. By the end of the trapping season, pelts are worth approximately 2/3 of their full value.

Conditions of supply and demand existing with respect to mink pelts from the Yukon-Kuskokwim Delta have allowed profitable harvest of mink which are not biologically prime. Because of this I have tried to arrive at the mean date of economic primeness.

Economic primeness is the condition of mink pelts in which they command full or almost full value. Two methods were used to arrive at the average date of economic primeness, these being the aquisition of a series of mink pelts with a known date of capture and the inspection of a series of mink for which the date of capture was only generally known.

Due to the expense involved in acquiring a series of mink for which the date and location of capture were known, only a limited series was obtained. Information from these pelts is presented in Table 8. Persons evaluating the degree of primeness and value were fur buyers from the Bethel area including Jim Stevenson, Northern Commercial Co.; John Samuelson, local trader; Henry Jung, trader at Napakiak; and Joe Mendola, trader at Oscarville. It was the unanimous opinion of these and other traders in the Delta that during normal years an opening date of November 10 is optimum for mink trapping. They said that although most male mink were economically prime before this date, many of the females, particularly juveniles, were not. Most female mink were economically prime by November 10.

In interior and western Alaska, decreasing daylight and more severe weather conditions tend to restrict trapping pressure as the season progresses. It is to the trappers advantage to open seasons as early as possible.

TRAPPING: METHODS, PROCEDURES AND EFFECTS

Mink trapping generally begins when conditions are suitable for travel by dog team. In normal years many trappers are on their lines and have most of their traps set by November 5. The greatest trapping

Table 8.--Primeness, Condition, and Date of Capture of Mink From the Yukon-Kuskokwim Delta, Alaska

Sex	Date and Location of Capture	Extent of Unprime Condition	Value
F	7 Nov. 1961-Kasigluk	Fur moderately long, skin generally blue	1/2
M	8 Nov. 1961-Baird Inlet	Tail and closely adjacent hide blue	Full
M	8 Nov. 1960-Kasigluk	Tail blue	Full
M	10 Nov. 1960-Nunapitchuk	None	Full
F	10 Nov. 1960-Nunapitchuk	Tail blue	Full
F	10 Nov. 1960-Nunapitchuk	Tail blue	Full
M	14 Nov. 1960-Nunapitchuk	Tail blue	Full
M	14 Nov. 1961-Baird Inlet	Tail blue	Full
M	14 Nov. 1961-Baird Inlet	None	Full
M	14 Nov. 1961-Baird Inlet	None	Full
M	14 Nov. 1961-Baird Inlet	None	Full
M	16 Nov. 1960-Nunapitchuk	Skin yellow, Tail blue	Full
F	16 Nov. 1961-Baird Inlet	Tail blue, Fur flat	3/4
M	16 Nov. 1961-Baird Inlet	None	Full
M	19 Nov. 1960-Nunapitchuk	None	Full
F	19 Nov. 1961-Baird Inlet	None	Full
M	20 Nov. 1960-Nunapitchuk	None	Full
F	20 Nov. 1960-Nunapitchuk	None	Full

effort is put forth during the first two weeks of the season, and the degree of success or failure at this time often determines the total effort that will be expended.

Methods of capture include use of snares, small caliber rifles, steel traps and wire traps (taluyaks).

As a trapping method, the use of snares has almost completely passed out of the picture except for taking beaver and otter. With these animals it is used whenever possible.

Rifles are often very effective, particularly during periods of warm weather or near areas of open water where mink are active above the ice. Trappers carry .22 caliber rifles in their sleds; these firearms are used to kill mink and other small game whenever the opportunity arises. Although in most cases observation of mink is incidental, these animals are often actively hunted and many are shot after luring them out of their holes. This is done by thumping the ground near a hole, stepping back a short distance and waiting until the animal sticks its head out. The gun muzzle is held next to the hole. During years when mink are abundant, or in local areas of abundance, trappers seek out dens or holes mink have recently entered, and try to lure them out. If a trapper kills an animal in this manner he will usually repeat the procedure at the same hole in order to get other mink which may be there. Frequently, more than one mink is taken, usually from natal dens of the previous summer, and it is assumed that the mink killed are of the same litter.

Size $1\frac{1}{2}$ side spring traps are the type of steel trap most frequently used. Weather conditions are an important factor limiting their effectiveness. Blowing snow and freezing rain often render steel traps useless. At the opening of the 1960-1961 trapping season, mink sign was abundant and snow conditions were favorable for the use of steel traps. Shortly after the legal trapping season opened, there was a heavy snowfall followed by high winds. The resulting conditions reduced the efficiency and caused the loss of many steel traps. Trappers usually set their steel traps close enough to their camps to allow checking at regular intervals except during the most severe weather conditions.

Several kinds of sets are used, but the most common and most effective is in the entrance of holes observed to be used by mink. Traps are also set in runways on top of pingos. These runs are very definite and may appear as completely enclosed tunnels through matted grass. Trappers make no attempt to conceal their traps and the mink aften go around or jump over them. At certain times there is considerable loss of value in steel-trapped mink through the action of red foxes, and smaller mammals which also frequent pingos. Red foxes often sit on the tops of pingos, and will usually discover and partially destroy captured mink, particularly if they are left for extended periods of time, as during prolonged periods of adverse weather.

The most important method of catching mink in the Delta involves the use of what are erroneously called fish-traps. Mink traps evolved from a type of fish-trap which is extensively used to catch blackfish. Modifications required to capture mink greatly reduce the ability of the traps to catch blackfish. In recent years, traps of this type have been modified to the point that they catch no blackfish.

In the following discussion the Eskimo term taluyak (ta lou′yuk) will be used when reference is made to the trap used for mink and the term "fish-trap" will be reserved for the type used to catch blackfish. Old fashioned willow <u>taluyaks</u> differ from fish-traps (Fig. 10) in one respect. The throat opening is large enough to allow a mink to enter (approximately 4 in. in diameter). This decreases its effectiveness as a fish-trap in that it allows blackfish to escape after they have entered.

Advantages of willow <u>taluyaks</u> are that they will catch some blackfish, which may serve as bait, and it appears as a more completely concealed area, one that a diving or swimming mink is more likely to enter. Disadvantages of the old style <u>taluyaks</u> are that they are heavy and hard to repair if a captured mink damages them. They also tend to become clogged by debris.

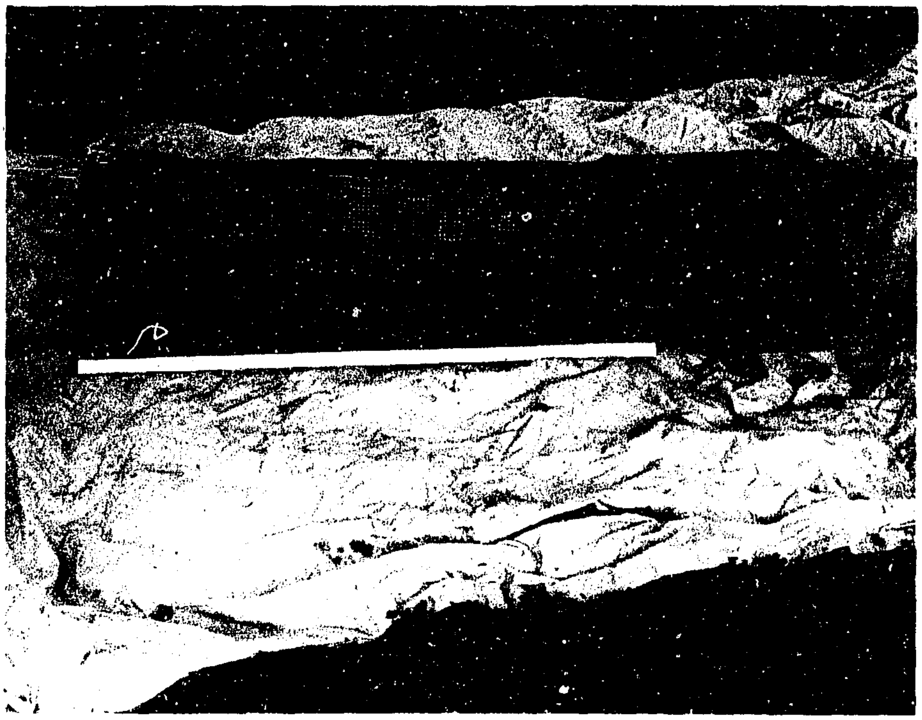
The next step toward development of the modern <u>taluyak</u> is illustrated in Figure 11. It consists of a wire throat and body built around a willow frame. The wire has a rectangular mesh of .25 to .50 in. These traps have the same drawbacks as willow <u>taluyaks</u> except that they are lighter and will withstand more abuse. Also, captured mink will not damage them as much. Advantages of this trap are essentially the same as with the split willow traps.

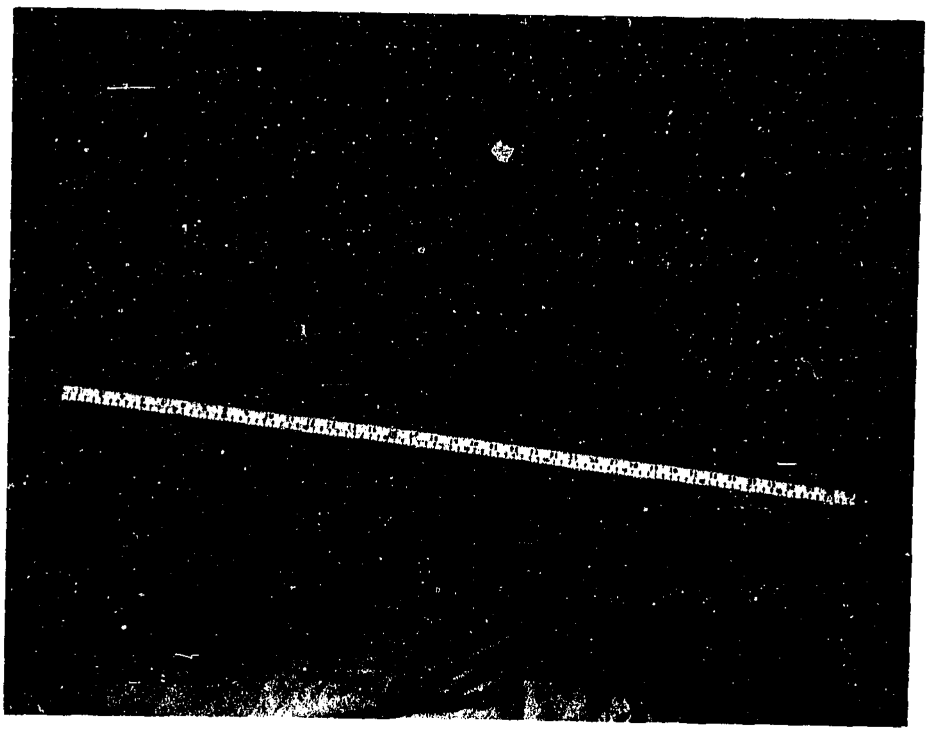
The most widely used type of <u>taluyak</u> is made entirely of one inch mesh chicken wire, and is constructed without a frame. Its relative dimensions are shown in Fig 12. According to the natives, this type of <u>taluyak</u> is the most desirable because of their lightness, ruggedness and flexibility. If crushed or bent, wire taluyaks are merely reshaped. Trappers going to fall camp usually take a roll of wire with them and

Fig. 10 A willow fishtrap used to catch blackfish. The object in foreground is a dip net used to remove fish from the trap. White meter stick indicates size.

Fig. 11 A wire and willow fishtrap used to catch blackfish. This type is sometimes used to catch mink. The white stick is a meter stick.

Fig. 12 Taluyak used exclusively for mink. Note the large mesh wire and size of throat opening.





spend their evenings constructing traps.

The use of taluyaks for catching mink has been strongly criticized because: captured mink are left underwater, and pelts become damaged due to slipping of the hair; taluyaks may be abandoned or lost and continue to take mink as long as they remain intact. From evidence I have found regarding trapping conditions and methods, I feel this critism is unjustified. Unorthodoxy is not grounds for making its use illegal. According to people who grade and buy these pelts, the percentage of skins damaged in this manner is very low (Dededer, Sheppard, Stevenson, Mendola, viva voce). Out of 23 trappers who were asked how long they thought dead mink could remain underwater without damage to the fur, all claimed one week, and most said two weeks or more. This is certainly the case with beaver caught beneath ice. These estimates were verified by Mr. George Sheppard of Mt. Village who handles a large share of the mink from the lower Yukon River. It should be pointed out that sloughs in which these traps are set are often covered with a thick layer of ice, and the water beneath is close to freezing.

The most important point against use of taluyaks is that they are sometimes left in the water after the legal season has closed, or that they are lost. Any kind of trap lost or abandoned will continue to catch mink. Animals lost in this manner represent a shameful waste. In general, trappers remove their taluyaks when ice becomes too thick to chop through easily (usually in late December). A common practice is to place taluyaks on the tundra with grass in the throat.

In the Chevak area, near Hooper Bay, abandonment of taluyaks has been a problem in the past, perhaps as the result of proximity of enforcement activity during a period when this traditional gear was illegal. Several informants from that area said they have seen taluyaks while they were gathering bird eggs(during early June) and some of the traps contained three or more mink skeletons.

Most of the traps in the water at the time of spring breakup are crushed by moving ice and debris.

Abandonment of taluyaks is a problem that is being resolved. Traders in the area have always encouraged trappers to remove their traps, and increasing cost of materials has been an added incentive. Each taluyak represents an investment of approximately $3.00 and 2½ hours of labor. Under normal trapping conditions (traps being removed each season) 16 gauge wire taluyaks will last three or four years. One of the biggest steps toward encouraging removal of these traps after the trapping season was taken at the 1961 spring meeting of the Alaska Board of Fish and Game. At that time use of taluyaks for the purpose of catching mink was legalized.

Inherent advantages of the taluyak far outweigh its disadvantages. Efficiency of this trap lies in the fact that it will continue to catch mink after one has already been caught. Mink caught are drowned in a matter of minutes and are not subjected to starvation and exposure as are animals caught in steel traps. Because of the good condition of mink caught in taluyaks they are used as human food, particularly by people in the southwestern part of the Delta. Another important consideration is that dead mink are protected from damage caused by foxes and other animals. According to local traders in the area, between 75 and 85 per cent of the total catch of mink is taken by taluyaks.

Taluyaks can be used only under conditions similar to those existing in the low wet country of the Yukon-Kuskokwim Delta. Here there are numerous small sloughs draining the many lakes of the area. In low, wet tundra areas blackfish are abundant whereas in the higher areas of the Delta the number of lakes and slough decreases. In the latter areas lakes are small and isolated; and, according to the natives, blackfish are less abundant.

Taluyaks are usually placed in narrow sloughs, about $2\frac{1}{2}$ feet below the surface of the water. They are held against the bank by diagonally placed sticks and bushes. Sloughs in which taluyaks are placed have steep banks. Undercut banks are considered undesirable. If the water where a trap is to be placed is deeper than the desired depth, the trap is suspended by a string or wire (Figs. 13 and 14). The most desirable sets are at the confluence of two small sloughs, or where a small slough leaves a lake.

Suitable sites for this type of trap are limited to portions of sloughs, outlets or inlets of lakes, and other restricted bodies of water that for some reason do not freeze rapidly. A trapper is very fortunate to have 40 or more such trapsites on his line. With few exceptions, men from Nunapitchuk and Kasigluk rarely have more than 25 such sites on their lines.

Conditions which motivate a mink to enter a taluyak are a matter of speculation. The fact that small sloughs (up to 4 ft wide) are chosen as trap sites would increase the chances of intercepting a swimming mink. Apparently the most important factor is that taluyaks are covered with willows or the channel is blocked, creating both an

Fig. 13 Resetting a _taluyak_. This trap was set in the small ice-covered slough. Note the debris on the ice and in the trap. This debris often blocks the throats.

Fig. 14 Setting a _taluyak_ under thick ice (approximately 12 in.). String tied to the bush suspends the trap at proper depth under water, sticks in the hole hold trap against the bank and willows are used to direct mink into the trap.

obstacle for a mink to swim around and a sheltered area that a mink in search of blackfish would enter. The areas where taluyaks are most effective coincide exactly with reported areas of high blackfish abundance. These areas seem to have relatively low small mammal populations.

Trapping Pressure

In discussing trapping effort and the resulting pressure on mink populations, it is well to recognize the difference between a dedicated trapper and a man who goes trapping. To the former, long hours of hard work under severe conditions are well spent whether the catch is large or small. An example of the drive exhibited by a good trapper may help to illustrate my point. On several occasions during November, 1961, there were heavy snowfalls all of which ended in rain. During this time, I was at the camp of two Eskimos from the village of Kasigluk. During each rainy period one of the trappers would walk the rivers and sloughs, hunting mink with a rifle. I accompanied him on several occasions and was surprised to find how successful hunting during these wet periods could be. Four trips under these conditions produced five mink. The other man at our camp, and those at nearby camps preferred to remain warm and dry by their stoves.

One of the more successful trappers in Bethel has his camp on the north side of Baird Inlet, about two days travel by dog team from his home. His trapline varies between 100 and 140 miles in length depending on travel and trapping conditions. He has a single base camp from which several short lines extend. The longest leg of the line requires two days to cover and his nights on the trail are spent sleeping in the sled. The reported catch of this trapper during the 1960-1961 season was 106 mink. During the 1961-1962 season he reportedly caught 94 mink.

Most trappers have three or four lines which are 10 to 20 miles in length, radiating from their base camp. They try to return to their camp each night if possible. The average total length of most lines is between 45 and 60 miles.

During the first part of the trapping period, most able men in the villages go out on their traplines. They spend a week or two setting traps and making new taluyaks to replace old ones. When all traps are set they often return to their villages for a day or two to replenish the supply of firewood for their homes and to get additional supplies, including food for their dogs.

The first check of the traps is made upon returning to the lines. At this time they decide to either continue trapping in earnest or to just remain on the line, periodically checking traps. By the first week in December, the ranks of trappers have been thinned to those willing to cope with severe weather conditions and relatively short days. During the present period of high mink prices, the number of men remaining on the lines is surprisingly large.

Trapping with taluyaks usually ends by Christmas. By that time, the ice has become too thick to allow trappers to check more than a few taluyaks during the short daylight hours. The legal trapping season normally extends to January 31.

Table 9 shows the population and the number of trappers from each village in the Delta. Figures for the population of villages were ob-

Table 9.--Villages, Population, and Number of Trappers in the Yukon-Kuskokwim Delta, Alaska, During 1960

Village	Population	Number of Trappers	Per cent of Population Trapping
Akiachak	226	45	20
Akiak	189	7	4
Alakanuk	278	57	20
Andreafsky	350	22	6
Bethel	1258	15	1
Billmore Slough	20	5	25
Chaneliak	81	7	9
Chevak	312	40	13
Chefornak	126	22	17
Eek	194	18	9
Hamilton	35	10	28
Hooper Bay	456	39	8
Kalskag	143	13	9
Kasigluk	237	40	17
Kipnuk	217	40	18
Kotlik	57	11	19
Kwethluk	270	40	15
Kwigillingok	327	25	6
Kwiguk	349	39	11
Lower Kalskag	105	11	11
Marshall	180	32	18
Mekoryuk	238	19	8

Table 9.--Continued

Village	Population	Number of Trappers	Per cent of Population Trapping
Mt. Village	275	19	7
Napakiak	199	22	11
Napaskiak	205	35	17
Newktok	132	19	14
Nightmute	233	25	11
Nunapitchuk	330	41	12
Oscarville	51	5	10
Pastolik	30	5	17
Pilot Station	201	26	13
Pitkas Point	28	7	25
Quinhagak	136	8	6
Russian Mission	102	22	22
Scammon Bay	107	20	19
Sheldons Point	110	40	36
Tuluksak	138	22	16
Tuntatuliag	143	21	15
Tununak	171	30	17
Totals	8,239	924	11

tained from the Bureau of Indian Affairs Bethel District Office. Figures shown for the number of trappers from each village were obtained through a postcard survey followed by personal contact with as many villagers as possible. A letter with an enclosed postcard was sent to each of 37 villages in the study area. People receiving the letters were school teachers, postmasters, or village council presidents. Of the 37 cards sent, 34 were returned. Information for villages from which a postcard was not returned was obtained through personal interviews or through examination of Fur Dealer's Reports.

The population of villages on the Delta exclusive of Bethel is approximately 6,980 people most of whom are Eskimo. In these same villages there are 909 mink trappers representing 13 per cent of the population. Bethel is the only large town in the area and has a population of 1,258, a large part of which is white. In analyzing Table 9, it should be kept in mind that to include the population and number of trappers from Bethel, which is largely a trading and transportation center, gives a misleading picture of the percentage of the Eskimo population engaged in trapping, as it lowers this figure. I am aware of no full-blooded Caucasian, other than an occasional school teacher, who traps on the Delta.

Extent of Exploitation

Considering the large areas of suitable mink habitat present in the Delta, the conditions under which mink are trapped, the duration of the actual trapping period, and the shift in the economy of the local Eskimos from a subsistence to a wage earning economy, it is hard to believe that man constitutes more than a modifying influence upon population levels of delta mink. Fluctuations in harvest seem too severe to be attributed solely to trapping pressure. This can be illustrated by the fluctuation in harvest from the poor catch reported for the 1953-1954 trapping season (estimated at 10,000 to 12,000 pelts), to the exceptionally good catch of 40,000 pelts taken during the 1954-1955 trapping season. Effective trapping pressure would not allow a population increase (as reflected by the catch) to occur as rapidly as occurred between the 1953-1954 and 1954-1955 trapping seasons. It appears that a factor other than trapping pressure (and trapping success) is responsible for the wide fluctuations in harvest.

Further evidence in favor of the existence of a controlling factor other than trapping pressure is indicated by the decrease in catch between the 1959-1960 and 1960-1961 trapping seasons (25,000 and 10,000 pelts respectively). With the conditions existing in the Delta, this decrease was too large to be the direct result of trapping pressure.

To the present time, the number of men trapping from year to year has remained fairly stable at a high level when compared with other areas of Alaska. At present, these men are working traditional traplines, leaving large portions of the Delta, particularly interior areas, almost untouched.

It is my belief that at present levels, trapping pressure is not resulting in the over-exploitation of Delta mink populations. In fact, many portions of the study area could safely support an increased harvest.

Due to the physical limitations of the men and dog teams, increased trapping pressure would have to be the result of an increase in the number of men trapping mink. The majority of those presently trapping are exerting their maximum efforts, at least during the beginning of the trapping season. The changing economy probably precludes any increase in the number of trappers.

Fluctuations in Harvest

In order to determine the degree of fluctuations of mink harvested from the Yukon-Kuskokwim Delta, an attempt was made to utilize the Alaska Game and Fur Harvest Statistics compiled by the United States Fish and Wildlife Service. These reports were compiled from information obtained from trappers at the time they purchased their trapping licenses. Due to a combination of factors, including inaccurate trap er reports and failure of many trappers to purchase a license, the statistics are completely inadequate and erroneous. According to these Game and Fur Harvest Statistics the total number of mink harvested in Alaska as a whole, during Fiscal Year 1947 was 55,429. During Fiscal Year 1948 it was 23,268 and in Fiscal Year 1949, 27,468. These records show the harvest from the Yukon-Kuskokwim Delta for the same periods to be 338,465 and 0 pelts respectively.

The second means of trying to estimate numbers of mink taken in Alaska, and in particular areas within the State, relies on annual reports submitted by fur dealers. These reports were previously submitted to the U. S. Fish and Wildlife Service and are presently submitted to the Alaska Department of Fish and Game. This system is adhered to by most trading companies in Alaska but, to date, has proven inaccurate with respect to numbers of mink bought in the Yukon-Kuskokwim Delta. Inaccuracy in harvest data from this region is due to the fact that many traders in the area have simply neglected to purchase a Fur Dealers License, much less submit annual reports. This is further complicated by the fact that managers of cooperative native stores, operated by the Bureau of Indian Affairs (there are approximately 25 such stores in the Delta), have not been submitting annual reports to the Alaska Department of Fish and Game. This situation is presently being rectified through an agreement between the Department and the Bureau.

Data concerning the actual number of mink taken in the Delta are restricted to those compiled during the course of this study and were arrived at in two ways. Personal correspondence with Mr. Mike Dederer, President of the Seattle Fur Exchange, yielded a general idea of the number of pelts which they have received from the Delta. Records of cooperating traders in the Delta were then examined to see if they indicated a harvest similar to that reported by Mr. Dederer. By these methods, harvests for the 1959-1960 and 1960-1961 trapping seasons were estimated. The number of mink taken during the 1954-1955 trapping season (an exceptionally productive season) was calculated by dividing the average value per pelt into the total reported value of mink harvested during that season. It was also estimated on the basis of differences in numbers of mink purchased by certain traders in 1954 and 1960. Catch during the 1961-1962 trapping season was estimated from the number of pelts traders bought as of December 20,1961.

Resulting figures showing fluctuations between these four years are presented in the following section.

According to traders in the area, the catches made during the seasons of 1954-1955 and 1961-1962 represent the extremes in magnitude of harvests. The high value on this range is approximately six times larger than the low value.

COMMERCIAL VALUE OF MINK FROM THE DELTA

The actual commercial value of furs trapped in the Delta is difficult to evaluate for the same reasons that affect the acquisition of harvest information. This study revealed only scattered bits of information relating to the value of commercial harvests in the past.

There are many trading posts in the Delta including those of the Sheppard Trading Company with stores in Mountain Village, Chevak, Andreafsky, and Alukanuk; the Northern Commercial Company with stores in Bethel, Kwiguk, and Hamilton; and other smaller stores throughout the Delta. As far as can be determined, there are between 60 and 65 traders in the area. Although most of them do not handle large numbers of mink, in aggregate the total number is relatively large.

Bethel is the trading center of the lower Kuskokwim River area, and a large percentage of the mink harvested on the Delta is sold there. Seven traders in Bethel buy and sell mink, and there are an additional four traders in the near-by villages. Besides the Northern Commercial Company store in Bethel, three other store operators provided information which indicates the value of Delta mink.

During the 1960-1961 trapping season the four commercial establishments purchased approximately 3,420 pelts which were sold for approximately $103,136.00 or an average of $30.15 per pelt. The price received by trappers was $25.00 to $27.00 per pelt.

Mr. James Stevenson, fur buyer for the Northern Commercial Company store in Bethel, provided information concerning the average price per pelt received by the Company from the Seattle Fur Exchange. During the latter part of the 1958-1959 trapping season Mr. Stevenson shipped 644 mink pelts (mostly late caught) for which the N. C. Company received $13,900 or an average of $29.34 per pelt. During that same year he made an earlier shipment of 1,297 pelts for which the company received $50,766 (an average of $39.14 per pelt). During the 1960-1961 trapping season four shipments totaling 1,804 mink pelts were sold by the N. C. Company, Bethel store. They received $55,651.20, or an average of $30.85 per pelt for everything including weak and poor skins.

The estimated cash value of fur sold by traders and trappers in the Delta, during trapping seasons mentioned in the previous section is as follows:

Trapping Season	Number of Mink Harvested	Value To Trappers	Value To Traders
1954-1955	40,000	$1,000,000	$1,206,000
1959-1960	25,000	625,000	753,750
1960-1961	11,000	275,000	331,650
1961-1962	7,000	175,000	211,050

PROJECTED VALUES OF MINK AND OTHER FUR RESOURCES OF THE YUKON-KUSKOKWIM DELTA

Potential values of any natural resource are certainly matters of speculation, dependent on a great many variables which are apt to change.

Mink resources of Alaska, and the Yukon-Kuskokwim Delta in particular, are presently enjoying a period of good demand, with fair to good prices. The immediate outlook for mink from the Delta is good. France and Italy, the greatest markets for these mink, are experiencing a rising economy, with a corresponding rise in the demand for luxury items such as mink. Prospects are that the Common Market Nations will continue to experience a rising economy. Barring tariff wars or a change in styles from short to long-haired furs, the Delta mink should continue to be in demand.

On the basis of information obtained during this sutdy, I have made estimates of the cumulative potential value of mink and other fur resources of the Yukon-Kuskokwim Delta and adjacent areas of Game Management Unit 18, based on 10-, 25-, 50-, and 100-year projected values.

The mean value of $23.00 per pelt for mink is a conservative estimate used here to balance the possibility of error in estimating the quantity of other fur-bearers taken. During 1960 and 1961, the average value per mink pelt was approximately $30.00

Mink

Range of harvest=7,000 to 40,000 pelts per year.

Mean harvest=18,000 pelts per year.

Mean value=$23.00 per pelt.

Average annual value=$414,000.00

Accumulated value, 10 years=$4,140,000.00

Accumulated value, 25 years=$10,350,000.00

Accumulated value, 50 years=$20,700,000.00

Accumulated value, 100 years=$41,400,000.00

Beaver

Average annual harvest=2,000 pelts.

Mean value=$13.00 per pelt

Average annual value=$26,000.00

Accumulated value, 10 years=$260,000.00

Accumulated value, 25 years=$650,000.00

Accumulated value, 50 years=$1,300,000.00

Accumulated value, 100 years=$2,600,000.00

Otter

Average annual harvest=300 pelts.

Mean value=$22.00 per pelt.

Average annual value=$6,600.00

Accumulated value, 10 years=$66,000.00

Accumulated value, 25 years=$165,000.00

Accumulated value, 50 years=$330,000.00

Accumulated value, 100 years=$660,000.00

Muskrat

Average annual harvest=80,000 pelts

Mean value= $.50 per pelt.

Average annual value=$40,000.00

Accumulated value, 10 years=$400,000.00

Accumulated value, 25 years=$1,000,000.00

Accumulated value, 50 years=$2,000,000.00

Accumulated value, 100 years=$4,000,000.00

Value of Combined Fur Resources of the Yukon-Kuskokwim Delta

Present annual value=$532,000.00

Accumulated value, 10 years=$5,321,000.00

Accumulated value, 25 years=$13,302,500.00

Accumulated value, 50 years=$26,605,000.00

Accumulated value, 100 years=$53,210,000.00

The importance of mink as a renewable natural resource of the Delta is clearly seen when it is considered that mink constitute 77.8 per cent of the total value of fur from the Delta. At present, fur is one of the few resources of this relatively "barren" area.

DISCUSSION

Economic Importance To The Area

Fish and wildlife were and still are the mainstay of the economy in the Delta. As stated previously, people inhabiting villages along the Yukon and Kuskokwim Rivers are mainly fishermen, those along coastal areas are sea mammal hunters and those living on the tundra depend on fish and small game. In the present-day economy of these people, the status of furbearers has been changed from that of supplying food and the necessary materials for making clothing to that of supplying a limited amount of food and an important source of income.

Mink pelts are traded for manufactured goods or are sold for cash which is then used to purchase goods. This source of income is important because it comes at a time of year when many families have no other means of obtaining cash. Actual degree of importance varies from village to village depending on their proximity to labor markets, amount of outside assistance received, and the productivity of historical hunting and trapping areas utilized by village members.

The most stable sources of cash to villagers are the Federal and

State funds received. Due to the short period of time cash remains in the hands of these people, and the monumental task of finding the amounts of wages earned during summer months this discussion will be confined to the economic importance of mink in the winter economy of the area, with one exception. This exception is a breakdown of the total annual income in the village of Napaskiak as reported by Van Stone and Oswalt (1960). They state the following:

> In the year 1954 the total cash income for the community amounted to approximately $12,000 for furs, $18,000 for wages, $16,000 for relief (Old Age Assistance, Aid to the Blind, and Aid to Dependent Children), and probably some $3,000 was received from other sources, such as special Bureau of Indian Affairs, and government insurance payments and Social Security.

Because of its close proximity to Bethel, opportunities for summer employment of people from Napaskiak are greater than in most villages; consequently, the amount of wages received by these people lowers the relative importance of fur in the overall income of this village. However, fur accounted for 24.5 per cent of its total annual income.

Federal and State aid to the 37 villages in the area amounted to approximately $286,914 for the months of October, 1960, through March, 1961. This includes General Assistance Grants, Old Age Assistance, Aid to the Blind, and Aid to Dependent Children. The approximate value of mink produced in this area during the 1960-1961 trapping season was estimated to be $275,000. The merchants in Bethel, dealing with the trappers of a large region, count heavily upon mink as a source of income, but the sale of mink pelts by trappers from this community adds relatively little to its overall economy. This is because of the larger economic base in Bethel and the small proportion of Bethel residents who trap. Residents of Bethel receive a large proportion of the welfare received in the Delta, but contribute few pelts to the annual catch of mink. With the exclusion of Bethel, State and Federal aid to the Delta during the six month period of October, 1960, to March, 1961, amounted to about $275,030 which is approximately the same value received for mink during the 1960-1961 trapping season.

The actual importance of mink varies from one trapping season to the next and was at a low point during the winters of 1960-1961 and 1961-1962. To merchants of the area, mink are a double source of income. Pelts themselves are sold for a profit, and money paid to trappers is often used to purchase goods from their stores. Many storekeepers claim that profit or loss in their operation depends upon the success of the mink trapping season.

Trappers, being self employed, are not entitled to receive government support. Consequently, families receiving winter income from mink receive no outside aid, and trapping becomes their only source of winter income.

In appraising the importance of money in a subsistence-wage earner economy such as exists in the Delta, it should be kept in mind that as time spent earning wages increases, the importance of money for buying food also increases, but at a faster rate. Food purchased at the local store is very expensive, especially in contrast to native foods which are available for the taking during certain periods of the year. At present, relatively little money is spent on food except for such things as sugar, salt, tea, coffee, flour and milk. Most cash is used to purchase clothing and equipment which will aid in obtaining food or in more fully exploiting the environment.

Cultural Changes and Their Influence On Trapping

Eskimos of the Delta, with the exception of those from villages along the Yukon River, have had much less contact with white men than most groups of Alaska natives. They are presently undergoing cultural changes that affect almost every phase of their way of life, including trapping activities. In former years fall and spring trapping was a family endeavor, with the men and older boys working the lines while the women did the skinning and camp chores. When the entire family unit was at the camp, young boys had an opportunity to learn trapping techniques. With the advent of government schools and compulsory attendance laws this situation began to change until [illegible] the men are actually on the trap line.

Another change which has affected trapping effort has been consolidation of the many small, widely spread villages into the few larger ones existing today. Villages existing today center around the trading posts, churches and schools which were non-existent in the past. This consolidation has resulted in families moving away from historical hunting and trapping areas, thus increasing the time and effort involved in traveling between homes and camps. Men in the camps must still provide for the comfort and safety of their families, and this involves periodic trips back to their respective villages to gather firewood, make repairs and do other chores as they are required. Once home they are reluctant to leave for the lines particularly if mink are not abundant, or during periods of adverse weather.

In general this situation has the net effect of lowering trapping effort. In most cases with which I am familiar, traplines are 15 or more miles from the villages. A day is required to go from, and one to return to, a village, and the time spent at home is usually two or three days. Each trip made means that four or five days are spent away from traplines. Fortunately taluyaks, which are used in this area to catch mink, need little attention and will continue to trap although they may already contain a mink or several muskrats. If steel traps are to be effective, they must be checked frequently to remove trapped animals before foxes or other animals damage them, and to remove snow which may cover them. Those men remaining on their lines and applying themselves to the task of catching mink invariably do better than those making frequent trips home.

With the present compulsory school attendance requirements, boys do not start trapping until they are at least 17 and in most cases those under 25 years of age are members of the National Guard, which often requires their services during part or all of the trapping season. In general the number of men engaged in trapping is decreasing as the younger people find different kinds of employment and the older people pass out of the picture. Almost every cultural change involving native peoples in this area removes them further from a subsistence type economy of which trapping is an important part.

One recent change which may affect trapping has been the introduction of motorized snow vehicles which can greatly increase the range of a trapper's operation. As yet, the importance of these vehicles can not be assessed, but it is hoped that it will increase mink harvests from the Delta.

Effects of Heavy Machinery Within The Study Area

Oil exploration in the Yukon-Kuskokwim Delta has introduced heavy machines and all the advantages and disadvantages associated with them. The area of most intensive oil exploration is within the boundaries of the Pan-American Napatuk Creek Development Contract, an area which includes 465,000 acres centered 40 miles west of Bethel.

Possible problems, insofar as mink are concerned, were first called to my attention by mink trappers who repeatedly stated that the activities of "tundra-buggies" had in some way decreased the number of mink they caught within the area of activity. Subsequent to receiving these reports I inspected part of the area from the ground and also from the air.

There are a large number of "buggy" trails which extend in every direction, and most of the larger lakes and sloughs are bordered by them. The majority of trails were made during 1958 and 1959. In June, 1961, they were clearly visible and in most cases appeared as two parallel rivulets when observed from the air.

Hopkins (1949) has reported a similar case which occured in the Imuruk Lake area of the Seward Peninsula. His example may shed some light on the effects of human activity on animals which den underground. Disruption of tundra vegetation by human activities results in subsidence due to excessive thaw. During 1945, according to Hopkins, a Caterpillar tractor had repeatedly crossed a gentle hill slope. The route of the tractor was first examined in 1948; at that time it was marked by long, swampy furrows indented 3-12 in. in the tundra. Investigation later in the summer showed a series of sink-holes 3-5 ft deep, connected by subterranean watercourses. These developed where the tractor had travelled upslope. Still later in the summer it was found that the roofs of connecting caverns had collapsed, and the course of the tractor was marked by narrow gullies 3-4 ft deep.

If effects such as these result from human activity in the Delta (as apparently they have), it is not hard to understand why many of the streams closely paralled by trails do not produce the number of mink they once did. Vertical sinkholes filled with water keep the surrounding soil abnormally moist. During winter months this water freezes and forms a wall of ice which, in early spring, constitutes a barrier to burrowing animals. In most cases streams or lakes too deep to ford have buggy trails along their margins. Trails of heavy machinery within a few feet of a bank are the ones causing damage to the denning habitat of the bank-dwelling animals.

It was concluded that disturbance of tundra vegetation by human activities in the Delta has apparently resulted in long-lasting changes which may be detrimental to local mink populations. It would be possible to eliminate or at least reduce this problem in the future by using heavy equipment only during the winter months, by avoiding the shores of watercourses whenever possible, by using the same trails once they are established, or by using helicopters for summer work (as is presently being done).

Climate as a Factor Affecting Mink Abundance

Effects of climatic conditions on animal life have been discussed by many authors with respect to a large number of animal species. General adaptations to life under particular climatic conditions are known to almost everyone. Detrimental effects of climate on animals are illustrated by mortality caused by severe floods or prolonged drought, in animals such as muskrats and waterfowl.

As stated previously, it does not seem probable that fluctuations in mink abundance as reflected by harvest are the result of trapping pressure alone. Trappers and traders in the Delta have often commented that good catches of mink are made following warm, dry summers (warm with respect to normal summers in this region), and low catches occur after cold, wet summers.

The relationship of catch and summer weather conditions did not become apparent until after the 1962 field season, at which time no microclimate studies had been conducted in the area. In the following discussion data from the U. S. Weather Bureau station at Bethel are used to indicate conditions existing in the general area. Ideally, microclimate data covering several years would be much more desirable and would give a truer picture of conditions affecting young mink in their dens.

Effect of Climatic Conditions On Trapping Effort and Success

Weather affects post-harvest abundance of mink by regulating trapping effort and effectiveness. Water level conditions at the time of freeze-up also influence trapping success. If freeze-up occurs during a period of abnormally high water levels, extensive protected areas are left under the ice as the water recedes. Mink can travel without being exposed or leaving any indication of their presence. Under these conditions they are hard to locate and pin down to one or a few holes. Severe cold, and thick ice conditions discourage trappers, especially during seasons of low mink abundance. Discontinuation of trapping during later parts of the legal trapping season results in unbalanced sex ratios of animals caught. During the 1961-1962 trapping season, the male:female ratio was 67:33 in a sample of 1,245 pelts. The importance of an imbalance such as this lies in the fact that at any given population level, poor trapping success results in more mink (particularly females) reaching the reproductive period.

Effect Of Climate On Survival Of Kit Mink

The second and most important period during which climate influences abundance is that period from the time kits are born until they emerge from natal dens in early August. Accurate harvest information is lacking except for the years 1954, 1959, 1960, and 1961.

I think that the primary factor responsible for population levels during any trapping season is the survival success of young mink born during the summer preceding the trapping season. However, other factors such as abundance of breeding females compound the effects of good or poor kit survival. As an example, if a high proportion of female mink survive to the breeding season, and the survival of kits is good, the resulting post-breeding season population would be higher than if a smaller number of females were producing kits. The extremes in abundance probably result during the occasional years when all the variables are positively or negatively effective.

Fluctuations in mink population levels (as reflected by harvests) are correlated with climatic conditions during breeding seasons. In the following discussion macroclimatic data is used to suggest micro-climatic conditions.

Major portions of the Delta are closely underlain by frozen ground, the upper surface of which determines the depth at which mink can den during any particular year. The depth at which active dens are found depends upon the rate and extent of thaw of the active layer.

In a discussion of annual thaw, Johnson (1952) states "...the depth of summer thaw depends on the climatic conditions etc., and may range between wide limits..." Carlson (1951) mentions other factors affecting depth of thaw in frozen ground including latitude, altitude, direction of exposure to sun, shading or decrease in radiation, reflection or intensification of radiation, proximity to large bodies of water, and proximity to local sources of heat.

The extent and rate [illegible]s from year to year. This is substantiated by three observa[illegible]h, at the time they were made, were thought to be of little consequence. Three inactive natal dens, active during the preceding summer, were excavated during July, 1961. All were beneath the level of frozen soil at the time they were uncovered. One active mink den and three active weasel dens were also excavated at this time. Active dens penetrated only as far as the level of frozen soil.

As mentioned previously, mink dens were almost always found under a bushy plant cover (Spirea beauverdiana or Salix spp.). During June and July of 1962, the depth to frozen soil was consistently greater under this type of cover than under moss and lichens or grass. On grass-covered pingos, depth to the surface of the frozen ground layer was 6 to 12 in., under moss and lichens 4 to 12 in., and under Spiraea and willows 8 to 18 in. Average depths under these plant covers were 6 in., 9 in., and 14 in. respectively. Natal dens were only a few inches above the permafrost table. Selection for deeper den sites would seem to afford greater protection from extremes in climatic conditions above ground level. It would be difficult to isolate any particular climatic factor as being most important with respect to its effects on young mink. Climatic conditions in general are important, and during a particular year one factor may assume greater importance than another.

The following conditions were found to occur during both 1960 and 1961 which were both years of unfavorable summer weather conditions: higher than average cloud cover during the period kits were born (approximately June 15); increased amounts of precipitation, and cooler temperatures. Records of cloud cover and temperature indicate that rates of thaw of the active layer were slower than during more favorable years, and dens were closer to surface levels, thus being more subjected to the effects of increased precipitation and decreased temperatures. Under existing permafrost and soil conditions, precipitation (especially for extended periods) would rapidly increase soil moisture, producing adverse conditions for young mink.

On mink ranches mortality in young and old can result from exposure to both warm-humid and cold-wet conditions (Gorham et al, 1960). Under temperature conditions existing in the Delta the problem of death due to heat exhaustion is not likely to occur.

Death due to cold-wet conditions in dens may be attributable to exposure or to disease such as pneumonia or distemper contracted by mink. Cold-wet conditions foster development of these diseases which are often fatal at least under ranch conditions. Distemper is one of the most serious diseases in mink throughout the United States and Canada. On ranches, almost all mink become infected during any given outbreak. Losses may be as high as 90 per cent in young mink, but average 30 to 40 per cent in adults (Gorham et al, 1960). In general the mustelids are highly susceptable to distemper; the ferret is almost 100 per cent susceptible, and is used in diagnosing the disease in mink.

Present information indicates only that mink populations, as reflected by harvest, are low following cold, wet summers. Whether this is the result of young animals suffering from exposure or from disease resulting from unfavorable conditions is not known. Also, unfavorable weather conditions appear to decrease the breeding success of summer prey species. This adversly affects the breeding success of mink by making it harder for the females to support themselves and their kits.

In recent experiments conducted by Aulerich et al. (1963) it was demonstrated that in ranch mink, more kits per mated female were whelped by females that received additional illumination after mating, than by the females exposed to normal light conditions. Perhaps extended periods of cloud cover during the gestation period influence the number of kits whelped by female mink in the Delta.

Years of known extremes in harvest occurred during 1954 when approximately 40,000 mink were harvested and in 1961 when approximately 7,000 were taken. Known harvests for 1959 and 1960 were 25,000 and 11,000 respectively. Information concerning harvests for intervening years was not available.

Figure 15 shows that the two years of known good catches were preceded by summers of lower-than-average precipitation while years of low catches were preceded by summers of relatively high precipitation (weather conditions during the period May 1 to July 31 being considered as important).

Figure 16 is a comparison of major differences in weather during 1954 and 1961. It is important to note that during the first month of life (approximately June 15 to July 15), which is considered a critical period, precipitation during 1954 amounted to less than one-half inch. During this same period cumulative cloud cover was less, thawing index (defined by Linell, 1953, as the total cumulative [degree F] days above freezing for a thawing season) was greater, average daily temperatures were greater, average daily winds less, and wind chill less than during May, June, and July of 1961. Wind chill was calculated using the formula $Ko = (\sqrt{WV \times 100} - WV + 10.5) (33 - Ta)$ where Ko = total dry-shade cooling in kilogram calories per square meter per hour, WV = wind velocity in meters per second, and Ta = temperature of the air in degrees centigrade (Siple and Passel, 1945).

The role of trapping effort and summer weather conditions are pointed

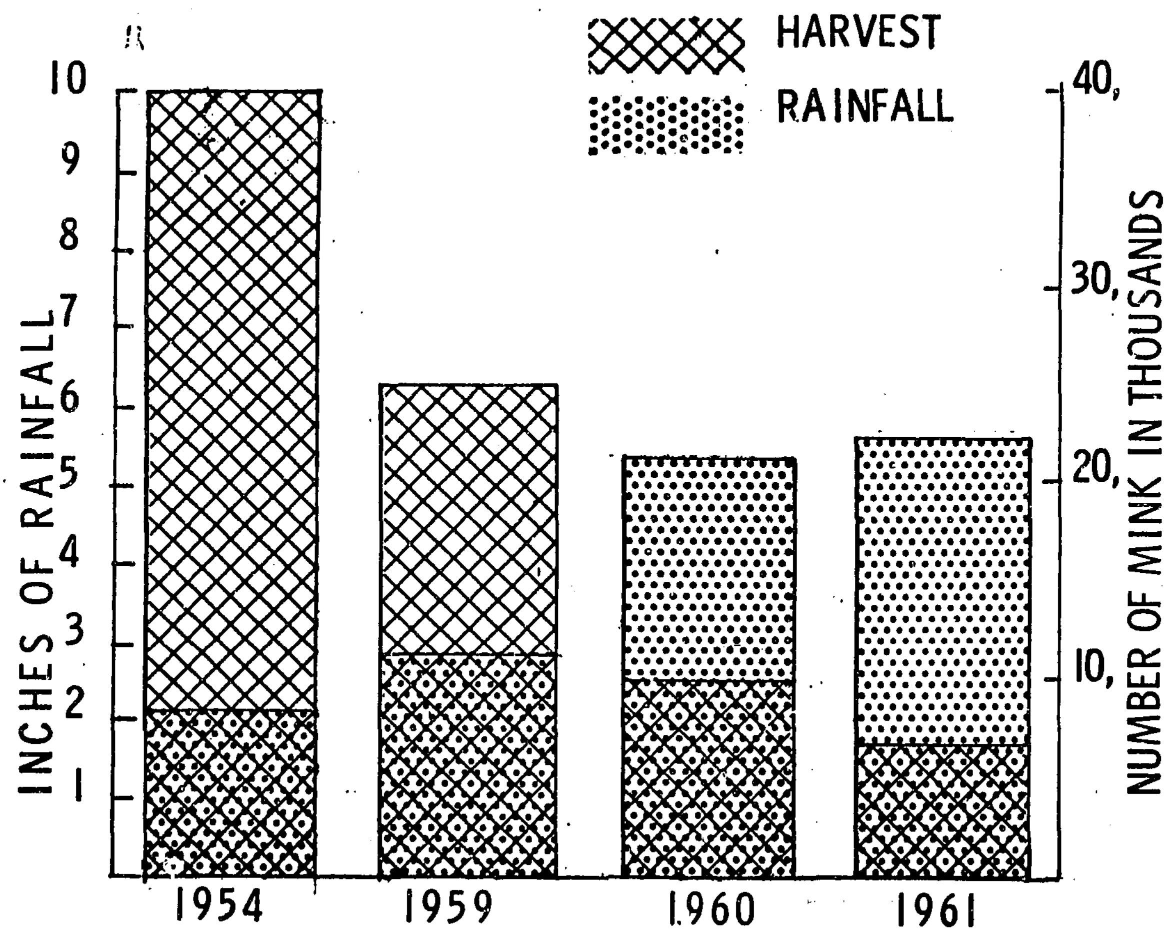
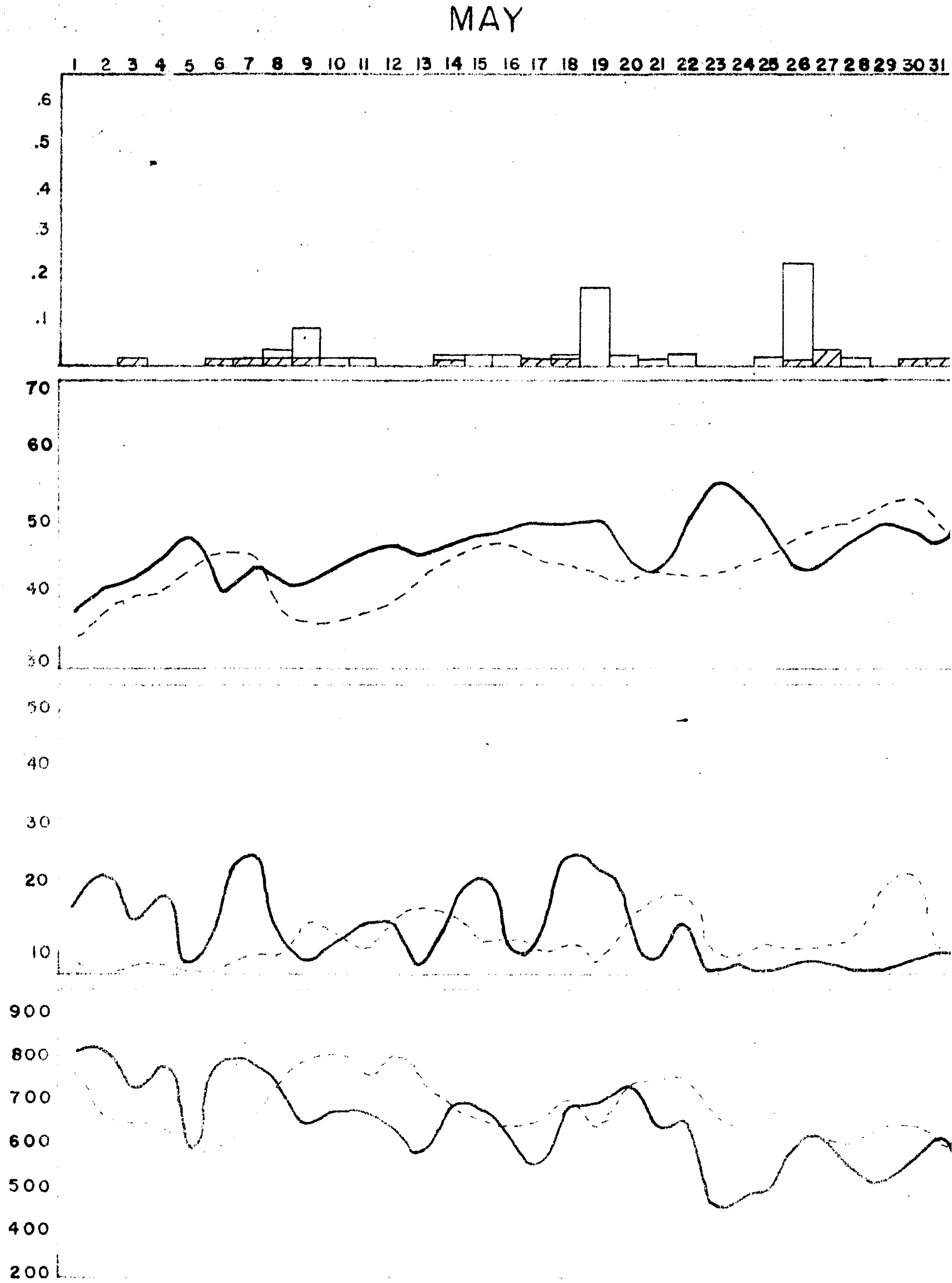


Fig. 15. Comparison of accumulated rainfall from May 1 to July 31, and mink harvests during the following falls. Normal rainfall for this period is 4.38 in.

Fig. 16. Comparison of climatic conditions from May 1, to July 31, for 1954, and 1961. Data taken from U.S. Weather Bureau records, compiled at Bethel, Alaska.



MAY
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
.6
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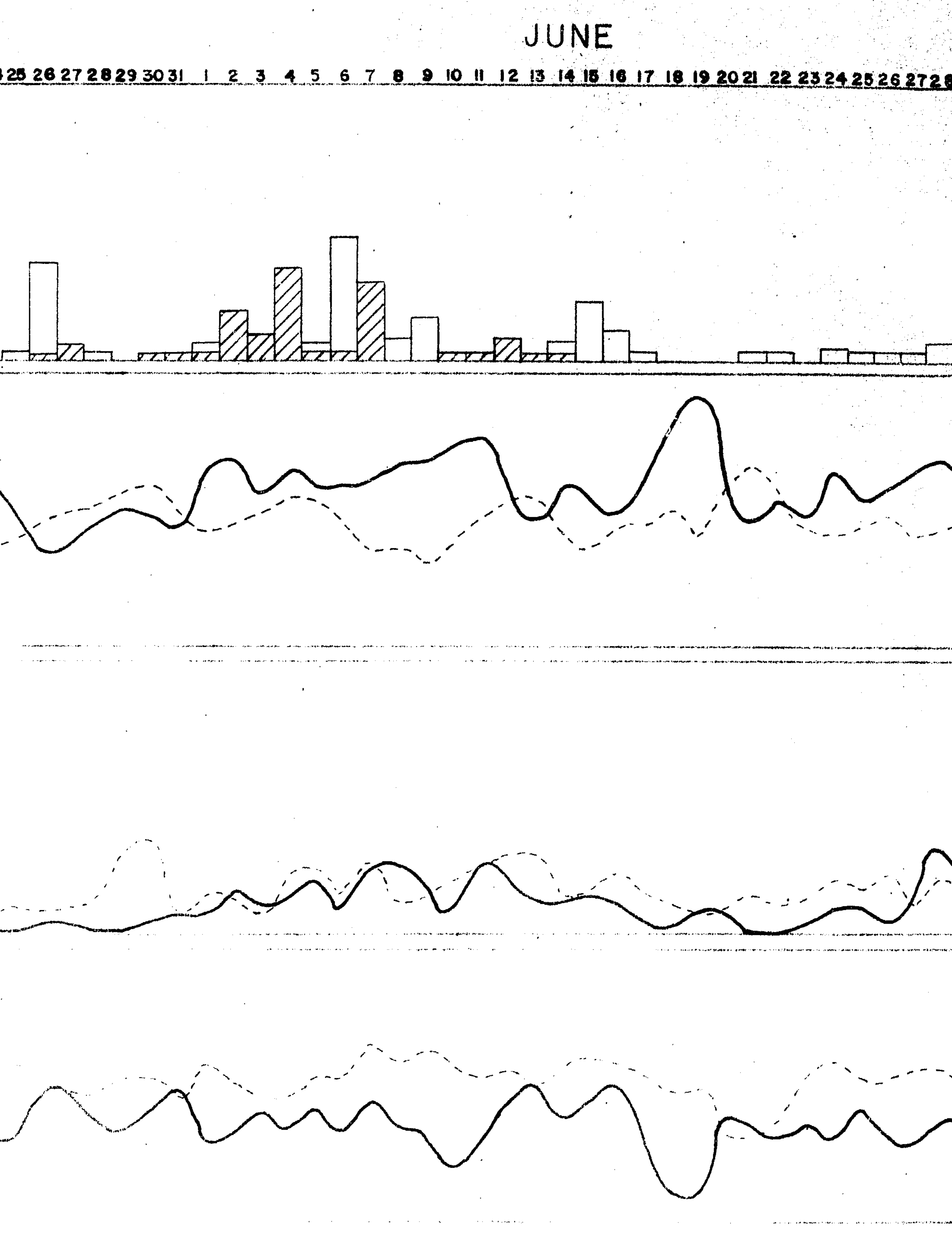
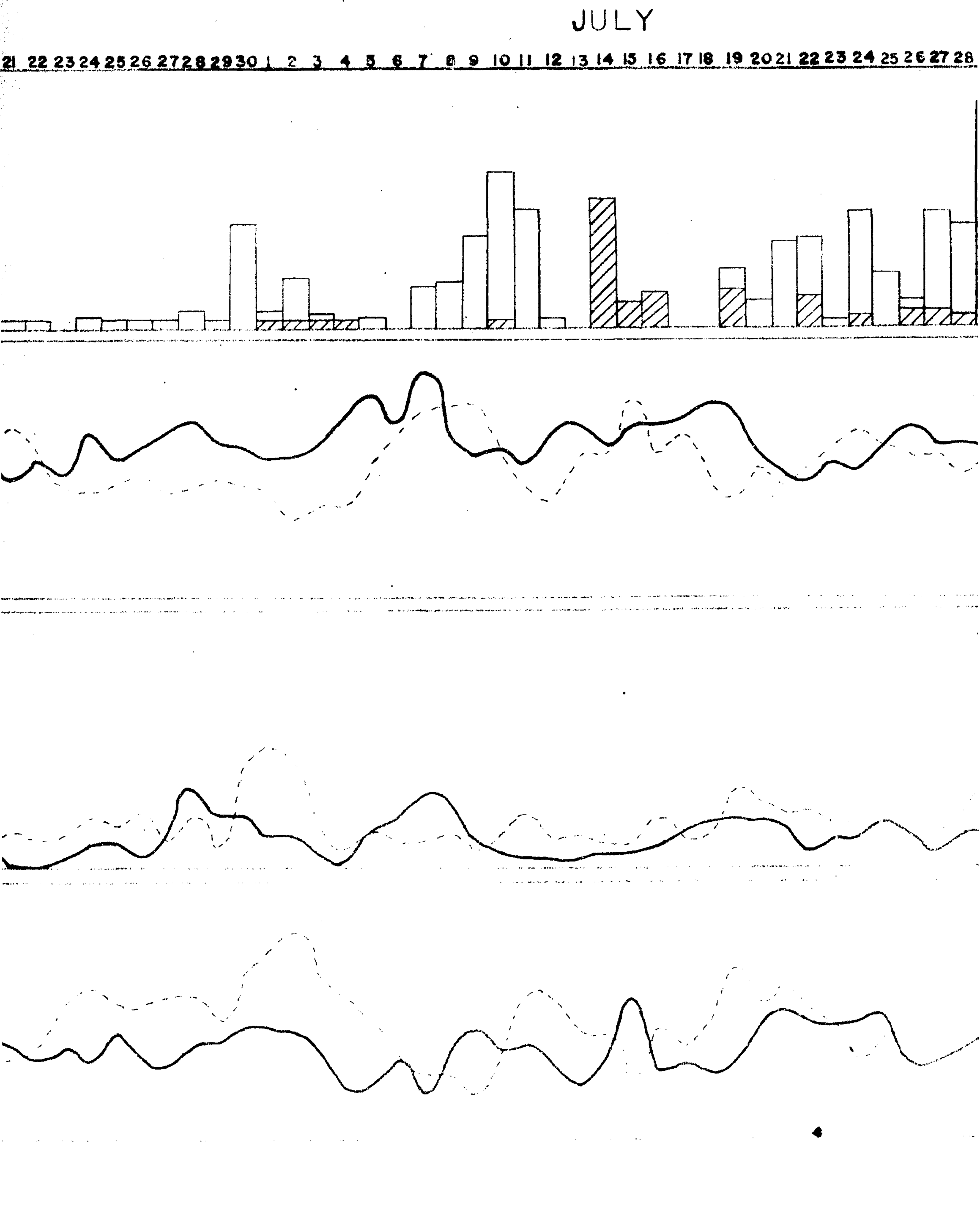
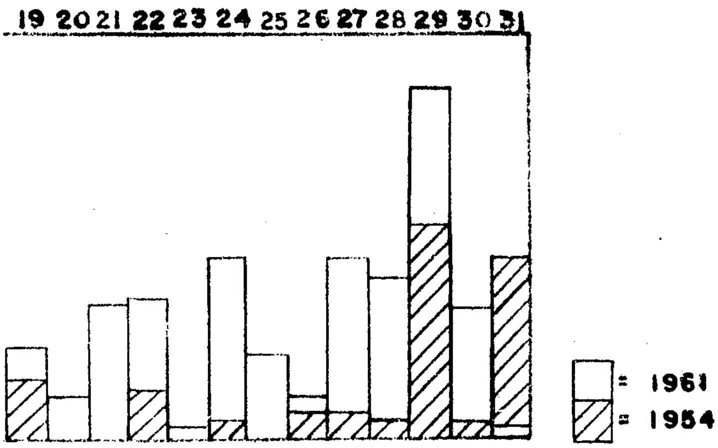
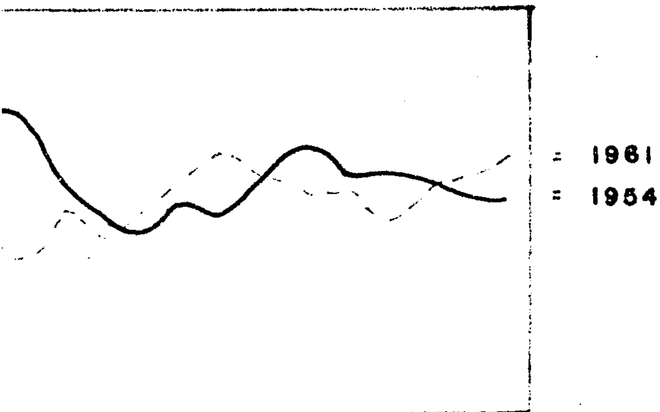

JUNE
25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27


JULY
21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28



INCHES OF

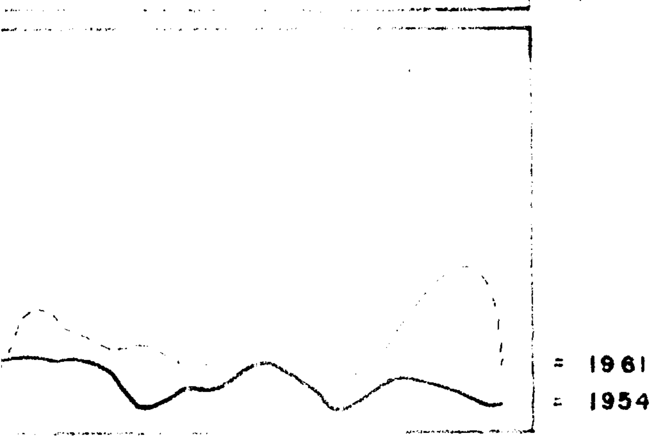
PRECIPITATION



AVERAGE DAILY

TEMPERATURE

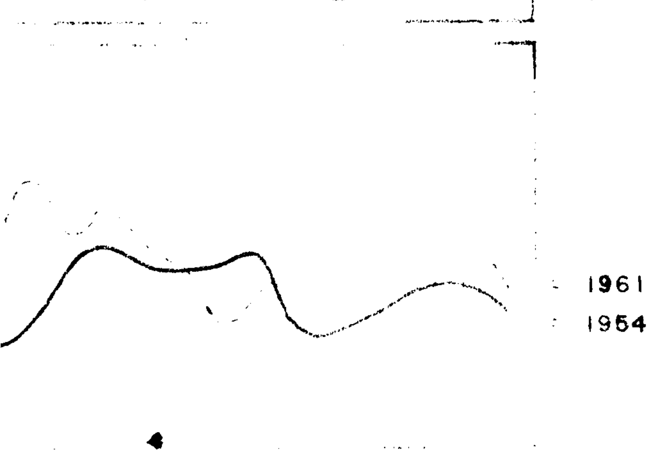
°F



AVERAGE DAILY

WIND

MILES PER HOUR



WIND CHILL

USING AVERAGE WIND SPEED
AND AVERAGE TEMPERATURE

out in the following discussion of the 1954 and 1961 fall harvests. During the 1953 trapping season weather conditions were unfavorable to trappers, due to cold, windy weather and thick ice conditions. The harvest of mink anticipated by trappers was never realized and most men stopped trapping early in the season (Sheppard, viva voce). The number of female mink carried through to the 1954 breeding season was relatively large and this, in combination with unusually favorable conditions during the denning period was apparently responsible for excellent kit production.

Conditions leading to the low harvest of 1961 were exactly reversed. During 1960, while this study was in progress, mink abundance as reported by trappers was low. They stated that if it had not been for the unusually mild winter conditions, it would have been unprofitable to trap. As conditions were good, they did trap but met with poor success. Continued trapping during the 1960 season decreased the ratio of males to females caught (59:41), reducing the number of females carried through to the breeding season. This in addition to poor survival of kits during the summer of 1961 was responsible for the poor harvest of that winter.

Information obtained during this study did not reveal the size of the mink population in the Delta, or the proportion of the population removed by trapping. However, the data indicate that when females comprise more than approximately 40 per cent of the harvest, the breeding population may be reduced to the point that a "normal" post-breeding population level could result only through a high rate of survival in kits.

Possibilities of Predicting Mink Abundance

In view of present indications it seems highly possible that predictions of relative mink abundance can be made, given accurate fur dealer records, knowledge of sex and age ratios of trapped mink and weather records of the breeding period.

I predicted a winter of low mink abundance and poor catches for the 1961-1962 trapping season. This prediction was based on the comparatively small number of mink taken during the 1960-1961 season, even though trapping conditions were favorable; the high proportion of females taken during this period (40.8 per cent of the catch, indicating that females normally expected to live to the breeding season were removed), and on the extremely poor climatic conditions prevailing during the 1961 breeding season.

During the 1961-1962 trapping season, trappers reported low mink abundance, and this in conjunction with poor trapping conditions accounted for the small harvest (the poorest remembered by local trappers).

Predicting harvests would be more difficult than predicting mink abundance because weather conditions during actual trapping seasons directly affect the harvest. Possibilities of accurately predicting weather during a future trapping period are not very great. However, harvests are usually good if mink are abundant.

Encouragement of Conservative Practices

The abandonment of set taluyaks after trapping operations have ceased has been one of the major objections to use of this trap. As explained previously, these traps will continue to capture mink, muskrats, and occasionally otter, as long as they remain intact. It is not unusual for people collecting eggs during early summer to find taluyaks still set, containing skeletons of mink and muskrats caught during the previous winter. Although the percentage of animals taken as the result of this practice is very small, this type of waste should be completely eliminated. The trapped animals can not be used in the home or sold for cash as they are partially or completely destroyed.

The legalization of taluyaks by the Alaska Board of Fish and Game in 1961 may well be the solution to this problem. Previously, trappers would leave taluyaks set after they had left their lines to avoid the risk of being caught with them. For some reason this situation has apparently occurred most often in the areas trapped by men from Chevak, possibly as the result of more intensive enforcement activities in that area, especially during the few years prior to 1961 when this type of trap was illegal. I feel that the recent legalization of these traps and the continued encouragement by conservation-minded people will prove the best means of overcoming this problem.

Mink are taken throughout the year whenever the opportunity arises, but the material or monetary value of unprime pelts is generally slight. Opportunities to shoot mink out of season occur most often during that period of the spring when men are hunting muskrats. At this time mink as well as most animals on the tundra are active and are often seen during the long evening hours of light. Those taken are usually not desired for home use, as pelts are past the prime condition of winter and have not yet reached summer primeness. Consequently, they are held for sale the following fall and are sold at a small fraction of their potential value. There is no justification for taking mink during the spring as those females surviving the winter could normally be expected to produce kits, some of which would be available during the fall trapping season. This practice will be very hard to overcome, as the philosophy of many Eskimo hunters is to take as much as possible, whenever possible. A similiar situation exists with respect to otter except that they are usually used in the home.

There exists a period during August when mink pelts have reached a condition generally termed summer prime. At this time the leather is creamy white as in winter prime pelts but the fur is short and reddish in color. Commercially these pelts are of little value but they are desired by the natives for making parkas and mittens, particularly for children. Childrens' garments are made with the fur side in, and the desirability of summer prime pelts lies in the fact that fur is short, fine and sparse. As a result, garments are not too bulky.

Men desirous of having mink garments for their children sometimes trap summer-prime mink. During this period, kits are just emerging from natal dens. Den sites are easy to locate because of scat piles, and the young mink are easy to catch. Kits are desired because of their relatively thin leather. Most mink caught at this time are young, ranging from 1/2 to 3/4 of adult size.

The actual realized value of mink taken in August is hard to evaluate. On one hand is the potential cash income of these mink if caught during the fall while on the other is the value (cash or otherwise) of home-made garments. A further complication is the fact that in many instances cash is a possession which can be used unwisely while clothing is always a definite asset.

Biologically this practice is difficult to evaluate because little is known about the degree of mortality in mink from the time they emerge from natal dens until they enter the commercial harvest. If mortality is high as some people imply (Errington, 1961), utilization of the kits is justified. At any rate, summer harvests are declining due to increased employment of men at canneries and commercial fishing operations.

Good trapping procedures, which apply in any area, should continue to be stressed, such as regular checking of traps to avoid destruction of fur, utilization of animals such as muskrats which are caught incidental to mink trapping, and the discouragement of the shooting of any animals which will not or can not be used.

Possibilities For Increasing The Value Of The Present Harvest

Several possibilities exist for increasing the value of mink which have been caught by trappers. They all involve the preparation and sale of pelts with the aim of marketing a uniform product. Unfortunately, production of a uniform product requires united effort, something which is hard to attain in a business as competitive and individualistic as trapping.

Commercial mink ranchers strive to produce pelts of uniform size by using pelt stretchers of the same diminsions within the size groups of small, medium, large, and extra large. Trappers in the Delta make their own pelt boards, which vary widely in size, and pelts produced by each trapper show a great deal of variation. According to local traders, uniform pelts are desirable and would command higher prices. Commercial stretchers can be obtained in quantity at reasonable prices (approximately

50¢ each). If people in a village could be persuaded to use these stretchers or homemade stretchers of uniform dimensions, pelts produced from that village would be in groups of uniform sizes.

A second possibility exists in marketing large numbers of pelts at one time. This again would involve cooperative effort on the part of all trappers within a village, but it would be to their advantage in that they would have more to bargain with. The procedure at present is for a trapper to trade his pelts one, or a few, at a time when the needs of his family demand it. As far as I know, trappers usually do not sell their pelts by mail, or on consignment.

Small trading outfits sell their pelts in lots, to their own advantage. They consistently receive higher prices for their mink than do the trappers. Uniformity and volume marketing are often means of obtaining higher prices, and there is no reason to think that it would not apply to mink produced in the Yukon-Kuskokwim Delta or from other areas of Alaska.

FUTURE RESEARCH NEEDS

Before mink present in the Yukon-Kuskokwim Delta can be managed on a sound biological basis, it will be necessary to obtain additional information concerning the influence of abiotic factors such as climate on survival of kit mink before they emerge from natal dens. If the influence of climate is as great as is presently assumed, examination of weather information will be an aid in making regulation proposals based on basic knowledge of relative abundance or scarcity of mink.

A microclimate study aimed at measuring the effects of climatic conditions in different habitats, such as near den sites and in surrounding areas, would be useful in explaining what constitutes favorable or unfavorable conditions for kits still in their dens.

Assessing the importance of weather during the trapping season is also important. It is a fact that heavy snowfalls reduce the efficiency of traps, and extended cold periods do not encourage extensive movements of mink. High water levels at the time of freeze-up also lower catches because mink often travel beneath ice as water levels continue to drop.

Evaluating the importance of climatic conditions during both denning and trapping periods can be done on a yearly basis by comparing harvest statistics with weather information. Over a period of years the effects may be more fully and accurately measured.

During early summer, female mink often den in the low-lying, swampy areas which are sometimes considerable distances from deep, flowing streams and sloughs. At the time of freeze-up mink are reported to be very active, apparently moving to deeper bodies of water in search of migrating blackfish. Trappers often set traps on the assumption that if mink are not in a particular area, they will eventually pass through. It is the contention of most native trappers that mink move toward the coast as fall progresses. An important facet of future work would be to assess the extent of movement with respect to distances and directions and the relative numbers of mink involved. This could probably be done most effectively by live-trapping and tagging mink during periods when the breeding population is relatively high.

The effects of trapping are not adequately understood. Accurate information is needed concerning the proportion of the total mink population harvested by trappers, and the effects of differences in the numbers of female mink that survive to the breeding season. It is important to try and obtain data about the size of the mink populations within selected areas of the Delta.

Knowledge concerning relationships between otter and mink, which are apparently utilizing the same ecological niche during the period when mink are feeding extensively on blackfish, would be biologically interesting and would provide factual information to prove or disprove the belief that otter have an adverse effect on delta mink.

Because of the limited amount of quantitative information obtained during the course of this study, any additional data would be a valuable contribution to our knowledge of mink from the Yukon-Kuskokwim Delta.

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APPENDIX A

WEIGHTS AND MEASUREMENTS OF

DELTA MINK

Table I.--Measurements of Mink Collected in the Yukon-Kuskokwim Delta, Alaska, During 1960-1961 Trapping Season

Sex	Weight, gr (pelted)	Length, cm	Tail Length, cm	Hind Foot Length, cm	Number
M	1361	60.2	17.2	7.1	JJB 90
M	1772	66.7	19.9	7.4	JJB 91
M	1445	68.0	21.8	7.4	JJB 92
M	1441	66.4	21.2	7.2	JJB 93
M	1418	60.7	18.5	7.3	JJB 94
F	528	51.3	13.6	5.9	JJB 95
F	568	56.8	17.9	6.4	JJB 96
M	1035	60.4	18.1	7.1	JJB 97
F	841	54.2	17.3	6.4	JJB 98
M	1495	63.2	19.0	7.5	JJB 99
M	1094	59.3	15.9	7.1	JJB 100
F	408	52.4	15.0	5.9	JJB 101
F	466	54.3	17.3	6.2	JJB 102
M	620	55.7	17.7	6.1	JJB 103
M	762	62.4	19.7	7.4	JJB 104
M	667	61.5	19.0	6.7	JJB 105
M	881	58.2	17.2	7.3	JJB 106
M	845	67.4	23.5	7.1	JJB 107
M	907	60.5	17.5	6.9	JJB 108
M	767	56.4	16.4	6.5	JJB 109
M	1082	61.3	18.5	6.9	JJB 110
M	1160	60.9	16.9	7.5	JJB 111

Table I.--Continued

Sex	Weight, gr (pelted)	Length, cm	Tail Length, cm	Hind Foot Length, cm	Number
M	925	63.4	19.5	7.1	JJB 112
M	1245	64.1	20.1	6.5	JJB 113
F	783	52.5	15.5	5.9	JJB 114
M	1338	61.8	17.8	7.4	JJB 115
M	974	60.5	18.0	6.8	JJB 116
M	1092	57.5	20.5	6.5	JJB 117
M	876	62.0	19.3	6.2	JJB 118
F	445	55.9	16.3	6.0	JJB 119
F	797	55.0	15.2	6.2	JJB 120
F	445	48.8	14.0	5.8	JJB 121
F	659	53.7	15.4	6.0	JJB 122
F	403	53.2	15.5	6.0	JJB 123
F	727	57.8	17.5	6.1	JJB 124
F	446	53.0	15.2	5.7	JJB 125
F	740	57.7	17.0	5.6	JJB 126
F	521	57.9	17.8	6.5	JJB 127
F	742	53.4	15.1	5.6	JJB 128
M	960	62.9	19.2	6.5	JJB 129
F	622	55.3	16.1	5.7	JJB 130
F	694	53.7	15.7	6.0	JJB 131
F	541	55.2	16.2	6.3	JJB 132
F	559	52.2	15.2	5.7	JJB 133
F	742	56.9	18.0	5.9	JJB 134

Table I.--Continued

Sex	Weight, gr (pelted)	Length, cm	Tail Length, cm	Hind Foot Length, cm	Number
F	703	59.7	17.0	6.2	JJB 135
F	720	55.5	15.2	5.7	JJB 136
F	562	52.2	14.7	5.7	JJB 137
F	546	58.5	18.2	5.8	JJB 138
F	729	53.6	15.2	5.9	JJB 139
F	590	58.1	18.3	6.0	JJB 140
F	390	49.9	15.9	5.7	JJB 141
F	958	60.5	18.4	6.3	JJB 142
M	828	61.0	19.0	7.0	JJB 143
M	692	64.5	19.5	6.5	JJB 144
F	608	59.5	18.0	6.7	JJB 145
M	670	59.7	20.2	6.8	JJB 146
M	674	57.9	17.4	6.5	JJB 147
Means					
M	1,037	61.9	18.8	6.9	
F	616	54.9	16.2	6.0	

APPENDIX B

PARTIAL LIST OF ANIMALS AND PLANTS PRESENT IN THE STUDY AREA

ANIMALS

Class Mammalia

Family Soricidae

Sorex cinereus hollisteri Jackson
(cinereous shrew)

Family Leporidae

Lepus americanus dalli Merriam
(snowshoe hare)

Lepus othus othus Merriam
(arctic hare)

Family Cricedidae

Subfamily Microtinae

Microtus oeconomus operarius (Nelson)
(tundra vole)

Ondatra zibethicus spatulatus (Osgood)
(muskrat)

Lemmus trimucronatus yukonensis Merriam
(lemming)

Family Canidae

Canis lupus pambasileus Elliot
(wolf)

Alopex lagopus hallensis (Merriam)
(white fox)

Vulpes fulva alascensis Merriam
(red fox)

Family Mustelidae

Mustela erminea arctica (Merriam)
(Weasel)

Mustela vison ingens (Osgood)
(mink)

Gulo luscus luscus (Linnaeus)
(wolverine)

Lutra canadensis yukonensis Goldman
(land otter)

Family Cervidae

Alces alces gigas Miller
(Moose)

Class Aves

Family Gaviidae

Gavia immer (Brunnich)

(Common Loon)

Family Anatidae

<u>Olor</u> <u>columbianus</u> (Ord)
(Whistling Swan)
<u>Branta</u> <u>canadensis</u> <u>minima</u> Ridgeway
(Cackling Goose)
<u>Branta</u> <u>nigricans</u> (Lawrence)
(Black Brant)
<u>Anser</u> <u>albifrons</u> <u>frontalis</u> Baird
(White-fronted Goose)
<u>Anas</u> <u>platyrhynchos</u> <u>platyrhynchos</u> Linnaeus
(Mallard)
<u>Anas</u> <u>strepera</u> Linnaeus
(Gadwall)
<u>Anas</u> <u>carolinensis</u> Gmelin
(Green-winged Teal)
<u>Spatula</u> <u>clypeata</u> (Linnaeus)
(Shoveler)
<u>Aythya</u> <u>marila</u> <u>nearctica</u> Stejneger
(Greater Scaup)
<u>Bucephala</u> <u>albeola</u> (Linnaeus)
(Bufflehead)
<u>Clangula</u> <u>hyemalis</u> (Linnaeus)
(Oldsquaw)
<u>Histrionicus</u> <u>histrionicus</u> (Linnaeus)
(Harlequin Duck)
<u>Somateria</u> <u>mollissima</u> <u>v.</u> <u>nigra</u> Bonaparte
(Common Eider)
<u>Oidemia</u> <u>nigra</u> (Linnaeus)
(Common Scoter)

Family Tetraonidae

<u>Lagopus</u> <u>lagopus</u> <u>alascensis</u> Swarth
(Willow Ptarmigan)
<u>Lagopus</u> <u>mutus</u> <u>nelsoni</u> Stejneger
(Rock Ptarmigan)

Family Gruidae

<u>Grus</u> <u>canadensis</u> <u>canadensis</u> (Linnaeus)
(Sandhill Crane)

Family Charadriidae

<u>Pluvialis</u> <u>dominica</u> (Muller)
(American Golden Plover)
<u>Squatarola</u> <u>squatarola</u> (Linnaeus)
(Black-bellied Plover)
<u>Arenaria</u> <u>interpres</u> (Linnaeus)
(Ruddy Turnstone)

Family Scolopacidae

<u>Capella</u> <u>gallinago</u> <u>delicata</u> (Linnaeus)

(Common Snipe)
Totanus melanoleucus (Gmelin)
(Greater Yellowlegs)
Calidris canutus (Linnaeus)
(Knot)
Erolia melanotos (Vieillot)
(Pectoral Sandpiper)
Erolia bairdii (Coues)
(Baird's Sandpiper)
Erolia plilocnemis tschuktschorum (Portenko)
(Rock Sandpiper)
Erolia minutilla (Vieillot)
(Least Sandpiper)
Ereunetes pusillus (Linnaeus)
(Semipalmated Sandpiper)
Limosa lapponica baueri Naumann
(Bar-tailed Godwit)

Family Phalaropodidae
Phalaropus fulicarius (Linnaeus)
(Red Phalarope)
Lobipes lobatus (Linnaeus)
(Northern Phalarope)

Family Stercorariidae
Stercorarius parasiticus (Linnaeus)
(Parasitic Jaeger)
Stercorarius longicaudus Vieillot
(Long-tailed Jaeger)

Family Laridae
Larus glaucescens Naumann
(Glaucous-winged Gull)
Larus canus Linnaeus
(Mew Gull)
Xema sabini (Sabine)
(Sabine's Gull)
Sterna paradisaea Pontoppidan
(Arctic Tern)

Family Hirundinidae
Tachycineta thalassina (Swanson)
(Violet-green Swallow)
Riparia riparia (Linnaeus)
(Bank Swallow)

Family Fringillidae
Passerculus sandwichensis anthinus Bonaparte
(Savannah Sparrow)
Zonotrichia querula (Nuttall)
(Harris' Sparrow)

Class Osteichthyes

Family Salmonidae

<u>Oncorhynchus</u> <u>gorbuscha</u> (Walbaum)
(pine salmon)

<u>Oncorhynchus</u> <u>keta</u> (Walbaum)
(chum salmon)

<u>Oncorhynchus</u> <u>tshawytscha</u> (Walbaum)
(chinook salmon)

<u>Oncorhynchus</u> <u>nerka</u> (Walbaum)
(sockeye salmon)

<u>Oncorhynchus</u> <u>kisutch</u> (Walbaum)
(coho salmon)

Family Coregonidae

<u>Coregonus</u> <u>cylindraceus</u> (Pallas)
(round whitefish)

<u>Coregonus</u> <u>nasus</u> (Pallas)
(broad whitefish)

<u>Stenodus</u> <u>leucichthys</u> (Guldenstadt)
(inconnu)

Family Dalliidae

<u>Dallia</u> <u>pectoralis</u> Bean
(Alaska blackfish)

Family Esocidae

<u>Esox</u> <u>lucius</u> Linnaeus
(northern pike)

Family Gasterosteidae

<u>Pungitius</u> <u>pungitius</u> (Linnaeus)
(ninespine stickleback)

Family Gadidae

<u>Lota</u> <u>lota</u> (Linnaeus)
(burbot)

PLANTS

Class Ascolichenes

Family Cladoniaceae

<u>Cladonia</u> <u>gonecha</u> (Ach.) Asagina
<u>Cladonia</u> <u>sylvatica</u> (L.) Hoffm.
<u>Cladonia</u> <u>gracilis</u> (L.) Wild.

Family Usneaceae

<u>Cornicularia</u> <u>divergens</u> Ach.

Class Musci

Family Sphagnaceae

<u>Sphagnum</u> <u>fuscum</u> (Schimp.) Klinggr.

Family Polytrichaceae

<u>Polytrichum</u> <u>juniperinum</u> Hedev.

Family Meesiaceae

<u>Aulacomnium</u> <u>turgidum</u> (Wg.) Schwaegr.

Family Hypnaceae

<u>Hylocomium</u> <u>splendens</u> (Hedev.) B.S.G.
<u>Pleurozium</u> <u>schreberi</u> (Willd.) Mitt.

Class Angiospermae

Family Poaceae

<u>Festuca</u> <u>altaica</u> Trin.
(rough fescue)
<u>Calmagrostis</u> <u>canadensis</u> (Michx.) Beauv.
(bluejoint)

Family Cyperaceae

<u>Carex</u> <u>aquatilis</u> Wahlenb.
(water sedge)
<u>Eriophorum</u> <u>angustifolium</u> Roth.
(tall cotton-grass)

Family Salicaceae

<u>Salix</u> spp.
(willow)

Family Betulaceae

<u>Betula</u> <u>nana</u> L.
(dwarf birch)
<u>Alnus</u> <u>crispa</u> (Ait.) Pursh.
(green alder)

Family Empetraceae

<u>Empetrum</u> <u>nigrum</u> L.
(crowberry)

Family Rosaceae

Spiraea beauverdiana Schneid.
(beauverd spiraea)
Rubus chamaemorus L.
(cloudberry)

Family Vacciniaceae

Vaccinium vitis-idaea L.
(mountain cranberry)
Vaccinium uliginosum L.
(log blueberry)

Family Gentianaceae

Menyanthes trifoliata L.
(buckbean)

Family Ranunculaceae

Caltha palustris L.
(yellow marsh marigold)

Family Asteraceae

Petasites frigidus (L.) Fries.
(arctic sweet coltsfoot)
Artemisia tilesii Ledeb.

Family Brassicaceae

Draba alpina L.

Family Polemoniaceae

Polemonium acutiflorum Willd.

Family Ericaceae

Ledum palustris decumbens (Ait.) Hult.
(narrow-leaved labrador tea)

Family Onagraceae

Epilobium angustifolium L.
(fireweed)

Family Ammiaceae

Angelica lucida L.
(sea coast angelica)